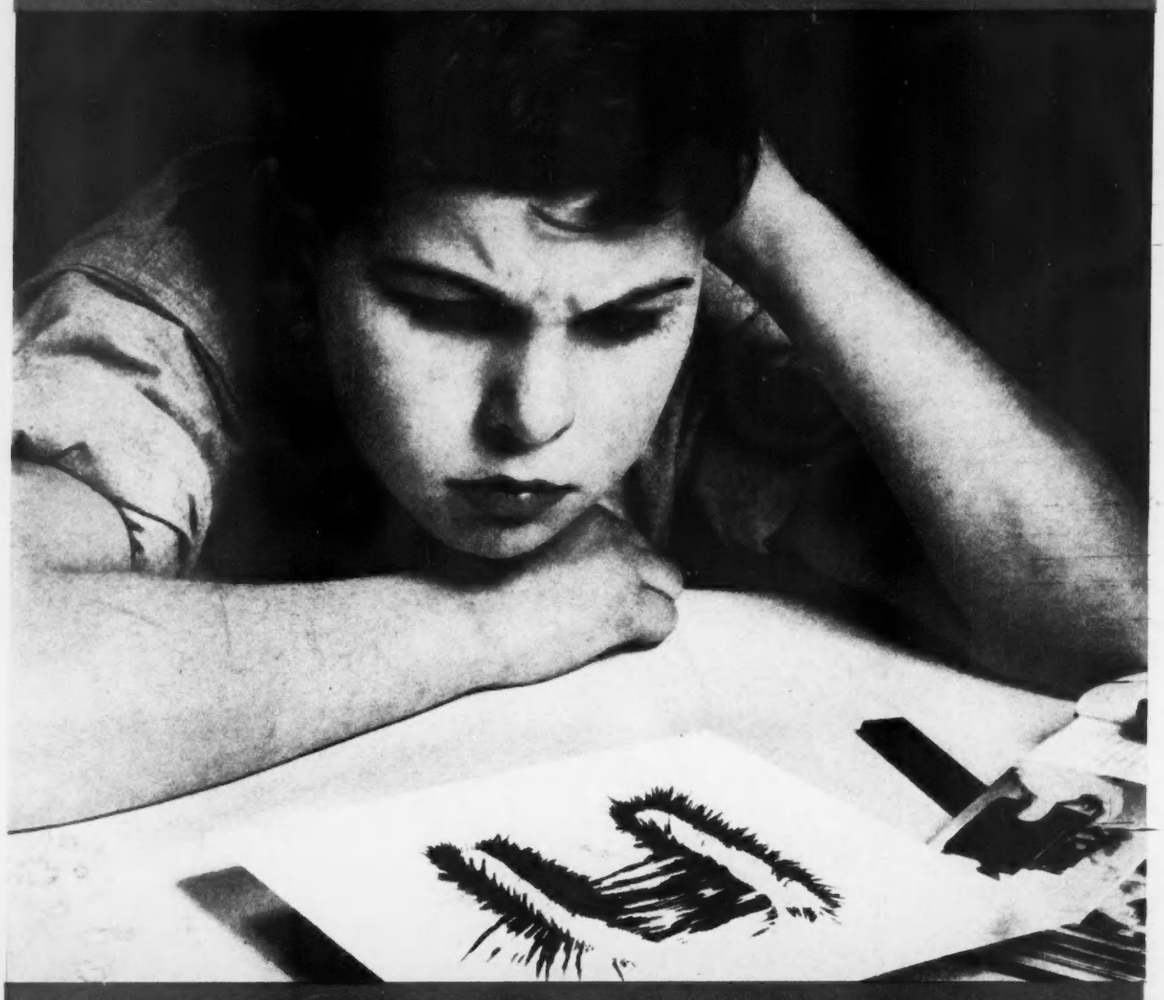
1580

The Engineer

OCTOBER 24, 1958 28 ESSEX ST., STRAND, LONDON, W.C.2 TWO SHILLINGS

EVERY PICTURE TELLS A **NICKEL** STORY



Extraordinary how the iron filings jump to it at the dictate of invisible forces. In industry too, things move swiftly in their planned ways when you bring nickel into play. Magnetic materials are only part of the nickel story. Mond can give you chapter and verse. Mond have the resources for research and development and supply technical publications for guidance in the choice and use of modern materials.

An important exhibition covering every aspect of nickel containing materials — will be held at the Aeronautical College, Cranfield from 18th to 21st November, 1958. Write to us for your invitation.

Enough Nickel for all needs

Plan ahead with MOND NICKEL

THE MOND NICKEL CO. LTD., THAMES HOUSE, MILLBANK, LONDON, S.W.1

TBA GM154

THE versatile 10-TON

Jones

The new JONES KL 10-6 lifts 10 tons; manœuvres comfortably in confined spaces; has the mobility of a crawler machine on soft ground; and, with a sectional lattice construction jib, gives impressive lifts up to 70ft (and beyond, with jury mast fitted). Power steering, 4-wheel differential drive and ample all-round outreach are standard features —together with the proved Jones direct mechanical transmission, giving precision load control, full engine power to all motions and remarkable economy in operating and maintenance costs. *Our Technical Representative will give you full details of standard mobile, truck and rail mounted versions.*

THREE YEARS' GUARANTEE ON ALL JONES CRANES

Jones cranes

take the load!

THE 600 GROUP OF COMPANIES

Distributed in the United Kingdom by
GEORGE COHEN SONS & COMPANY LIMITED, Wood Lane, London, W.12
Designed, Manufactured and Exported by their Associates K. & L. STEELFOUNDERS & ENGINEERS LIMITED Leeds

THE ENGINEER

Established 1856

No. 5361 **OCTOBER 24, 1958** VOL. 206

EDITORIAL CONTENTS

Leading Articles

Fitness for Purpose . . . 631
Dirty Hands . . . 632
Aircraft Engineers and Others . . . 632
Virtues of a Doubting Thomas . . . 633
St. Clement Danes . . . 633

Articles

100 Years Ago . . . 633
Jubilee Conference on Structural Engineering. No. II . . . 634
Sugar Beet Machinery . . . 636
Universal Beam Mill at Lackenby. No. II . . . 637
J. C. Chapman Stud-Welded Vibrating Wire Strain Gauge . . . 640
Automatic Layshaft Gear Cutting Line . . . 642
Programme Train Signalling at Watford . . . 644
Blind Landing of Aircraft . . . 648
Mechanical Printing and Newsprint Machine at Aylesford . . . 650
Progress of the Road Programme . . . 652
T. R. Robinson Pendulum to Atom Exhibition . . . 653
The Advanced Gas-Cooled Reactor, A.G.R. . . . 656
Crane Approach Warning System . . . 659
Multi-Faced Gripping Spanner . . . 659
Combined Desulphurising and Sulphuric Acid Plant . . . 659
Vacuum Drying . . . 660
Stainless Steel Slab Cutting Machine . . . 660
Magnetic Conveyors and Elevators . . . 660
Large Vertical Gear Shaving Machine . . . 661
Fire Appliance Chassis . . . 661
" Fluted Core " Radomes . . . 661

Continental Section

Cargo Ship M.S. " Magellan " . . . 663
Semi-Reflecting Glass . . . 663
Spinning Machine for Large Pipes . . . 663
Reorganisation of Swiss Watch Industry . . . 663

American Section

Progress in Controlled Thermonuclear Research in the United States. No. III . . . 664

LETTERS Vibration Waves in Concrete . . . 646
Clean Air and Public Opinion . . . 646

BOOK REVIEWS . . . 646

NEWS AND NOTES British Standards Institution . . . 651
Industrial and Labour Notes . . . 662
Personal and Business . . . 668
British Patent Specifications . . . 669
Launches and Trial Trips . . . 670
Catalogues and Brochures . . . 670
Forthcoming Engagements . . . 670

INDEX TO ADVERTISERS : PAGE 111 **CLASSIFIED ADVERTISEMENTS : PAGE 103**

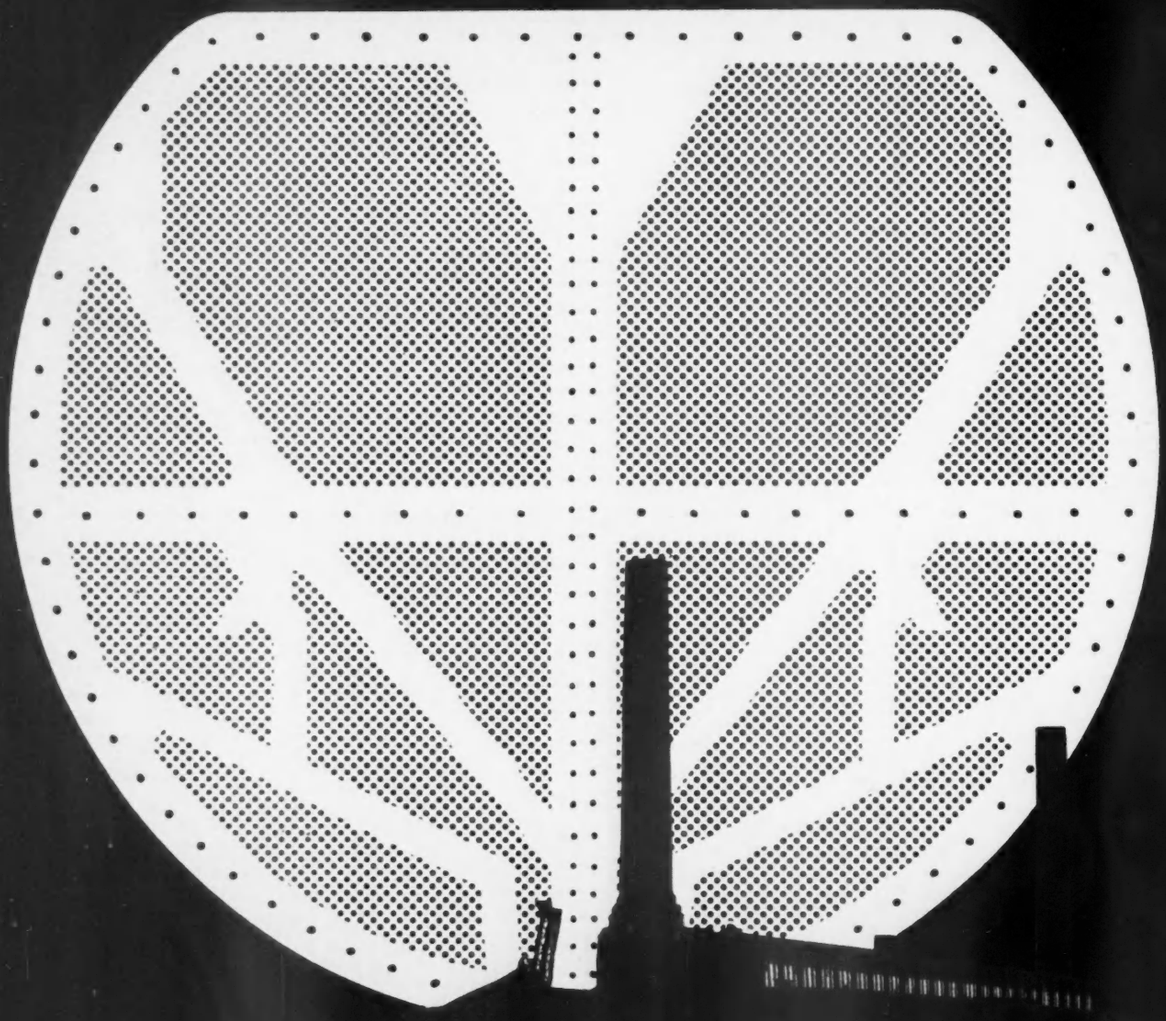
NOTICE TO READERS No undertaking can be given to return illustrations or manuscripts. Correspondents are requested to keep copies. No notice is taken of anonymous communications.

SUBSCRIPTIONS U.K. and ABROAD £5 10. 0. p.a., including postage (CANADA £5 5. 0.). Single copies 2s. each, plus 9d. postage. Also on sale at newsagents.

'THE ENGINEER' BUYERS GUIDE Published annually. One FREE copy is sent to all direct postal subscribers on publication and delivered by newsagents to all regular readers. Additional copies are obtainable at 7s. 6d. each. Postage 1s. 9d. extra.

Published every Friday by
MORGAN BROTHERS (PUBLISHERS) LTD., at 28, ESSEX STREET, STRAND, LONDON, W.C.2. Telephone: CENtral 6565

Condensers and Feed Heaters



Our fabricating shops at Hartlepool are equipped to build the largest power station condensers, and in the same works we build feed heaters, air ejectors, de-aerators and rotary cooling water strainers.

Also at Hartlepool we are equipped to build steam turbines and alternators up to 275 MW output, gas turbines, centrifugal and axial flow blowers, all of Brown Boveri design ; and also water-tube boilers of Foster Wheeler design for evaporating up to a million pounds of steam per hour.

In fact we can supply all the main items for a power station; from an industrial unit, designed to run on by-product fuels or waste heat, to the largest public supply station.

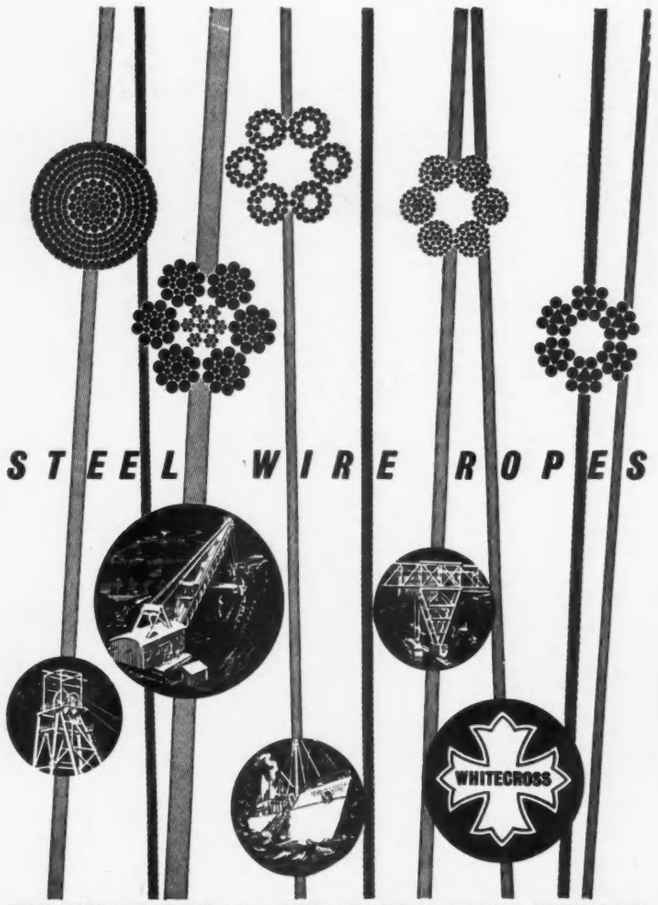
Richardsons Westgarth (HARTLEPOOL) Ltd.

R W G

A member of the RICHARDSONS WESTGARTH GROUP which co-ordinates the land and marine activities of :

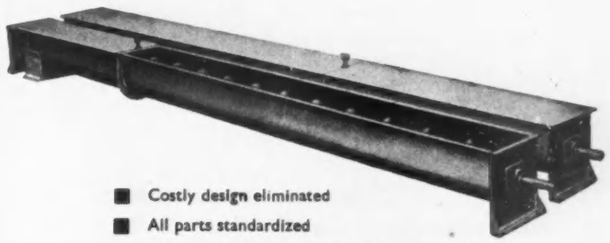
THE NORTH EASTERN MARINE ENGINEERING CO. LTD.
PARSONS MARINE TURBINE CO., LTD.
GEORGE CLARK & NORTH EASTERN MARINE (SUNDERLAND) LTD.
RICHARDSONS WESTGARTH (HARTLEPOOL) LTD.
THE HUMBER GRAVING DOCK & ENGINEERING CO. LTD.
RICHARDSONS WESTGARTH ATOMIC LTD.
ASSOCIATED COMPANY: ATOMIC POWER CONSTRUCTIONS LTD.

RICHARDSONS WESTGARTH (HARTLEPOOL) LTD., HARTLEPOOL, Co. DURHAM
and at: 58 Victoria Street, London, S.W.1. · 59 Mosley Street, Manchester, 2 · 75 Buchanan Street, Glasgow, C.1.



THE WHITECROSS CO. LTD WARRINGTON ENGLAND

MAXIMum production —minimum outlay



- Costly design eliminated
- All parts standardized
- Operate with minimum supervision
- Ideal for bulk handling in Flour Mills, Sugar Refineries, Fertilizer Plants, Cement Works, Chemical Plants, etc.

MAXIM

All types of Belt Conveyors and General Material Handling Equipment

CONVEYORS (ENGLAND) LTD.
Crabtree Manorway, Belvedere, Kent
ERITH 4223 & 5751

NEW BESCO All Steel PRODUCTION MOTORISED GUILLOTINES

In answer to demand for compact, lightweight, inexpensive sheet metal guillotines, F. J. EDWARDS have produced these motorised guillotines.

The frames cannot be broken by even extraordinary factory use, being of welded steel plate construction.

Planned to a price and designed for a job, they will cut their capacity day after day.

A new-design clutch, which is simplicity itself; all round and accurate gauges and an automatic built-in hold-down make the operator's job easier, quicker and safer.

In addition to cutting all kinds of sheet metal, these machines are also suitable for cutting fibre, plastics, mica, rubber, paper, card, with the blade ground to a special angle.

And they are from London stock, too.

Fuller details will be sent on request, together with prices and, if required, information concerning deferred payments in the United Kingdom.

Model	*Ungeared*	*Geared*	*Geared*
Capacity	36½" × 18 s.w.g. Mild Steel	36½" × 16 s.w.g. Mild Steel	49" × 16 s.w.g. Mild Steel

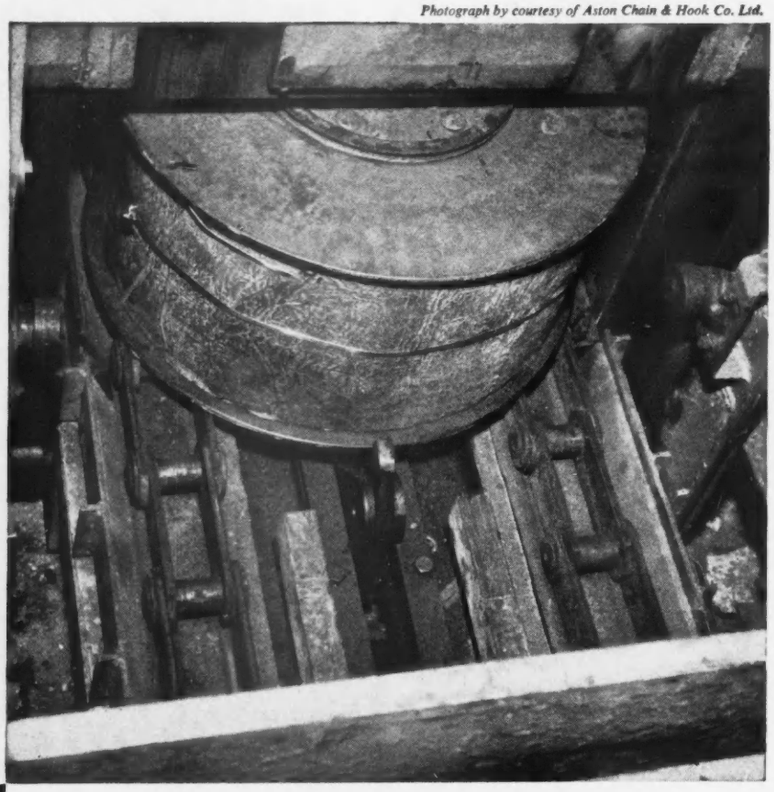
Besco sheet metal working machinery made by

F. J. Edwards Ltd

Edwards House, 359-361 Euston Road, London, N.W.1
Telephones: EUSton 4681 (7 lines) 3771 (4 lines) Telegrams: Bescotools Norwest London

Lansdowne House, 41 Water Street, Birmingham, 3
Telephones: CENtral 7606/8 Telegrams: Bescotools Birmingham 3

Photograph by courtesy of Aston Chain & Hook Co. Ltd.



NOTHING TO LOSE?

But your chains...

... are vital links in the manufacturing process. Always difficult to lubricate, chains are sometimes run dry for lack of a satisfactory lubricant. Then there really *is* something to lose: frequent maintenance or replacement means loss of production. The answer is dry film lubrication the Acheson way. The chains in the photograph convey heavy drums of copper wire through an annealing furnace. It is essential that there should be no fumes or carbonaceous deposits from the chain lubricant, otherwise the wire would be spoiled. Because cleanliness is essential in this application, the company has used for many years 'Aquadag'* colloidal graphite in water. The result is maximum efficiency from the minimum of maintenance and labour. The product is simply brushed on the links once a week. Although it is used sparingly to prevent the drums slipping and upsetting the timing sequence, 'Aquadag' provides full lubrication.

*Registered trade mark of Acheson Industries (Europe) Ltd., licensed user—Acheson Colloids Ltd.

dag dispersions **speed** production

REGD. TRADE MARK

ACHESON COLLOIDS LIMITED

Subsidiary of Acheson Industries (Europe) Ltd.

PRINCE ROCK · PLYMOUTH · DEVON

Enquiries to: TECHNICAL SALES AND SERVICE · 70 Hill Street · Richmond · Surrey · *Telephone:* RIChmond 5481 (3 lines)

Also Acheson Colloids Company, Port Huron, Michigan U.S.A., and Acheson Colloiden N.V., Scheemda, (Gr.), Netherlands

RUBBER AND SYNTHETIC UNITS

(to any specification)

IN

NATURAL, NEOPRENE SYNTHETICS

GASKETS, OIL SEALS, SHOCK UNITS

WHEELS, RUBBERISED CORK, SPONGE

PLASTIC FOAM RUBBER

SAM KAY RUBBER CO. LTD.

HOPE MILL · PORTWOOD PLACE · STOCKPORT

TELEPHONE: STO 2617/8

G · CLANCEY LTD.

CASTINGS

for

ALL TRADES

G · CLANCEY LTD.

BELLE VALE · HALESOWEN

TELEPHONE: CRADLEY HEATH · 69411 - 2 - 3

"...and it pays for itself in 5 years"

The increasing number of BRUSH Axial-Flow Turbines now being installed in steam-using industries is positive proof of their claim to pay for themselves in a very short time. If you use steam for space heating or processing and would like to know more about how to generate your own Power and improve your fuel efficiency, write to BRUSH asking for Publication No. 6f012/AD.

BRUSH

AXIAL FLOW TURBINES

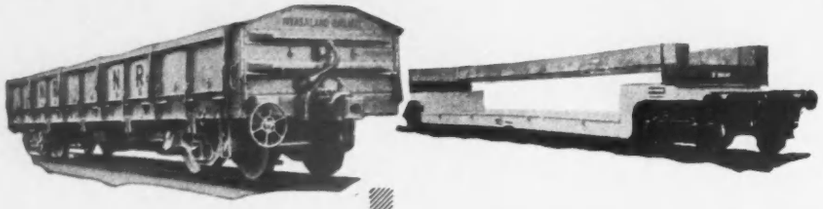
the logical choice

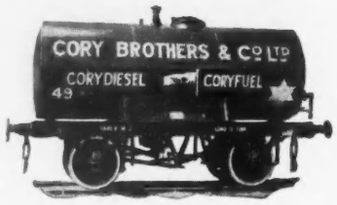
BRUSH ELECTRICAL ENGINEERING CO · LTD

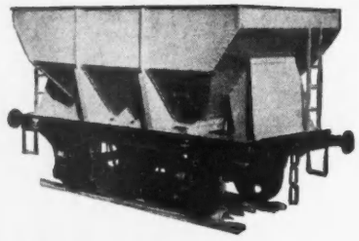
Loughborough · England *(Member of the Hawker Siddeley Group)*

AT 1

Cambrian rolling stock



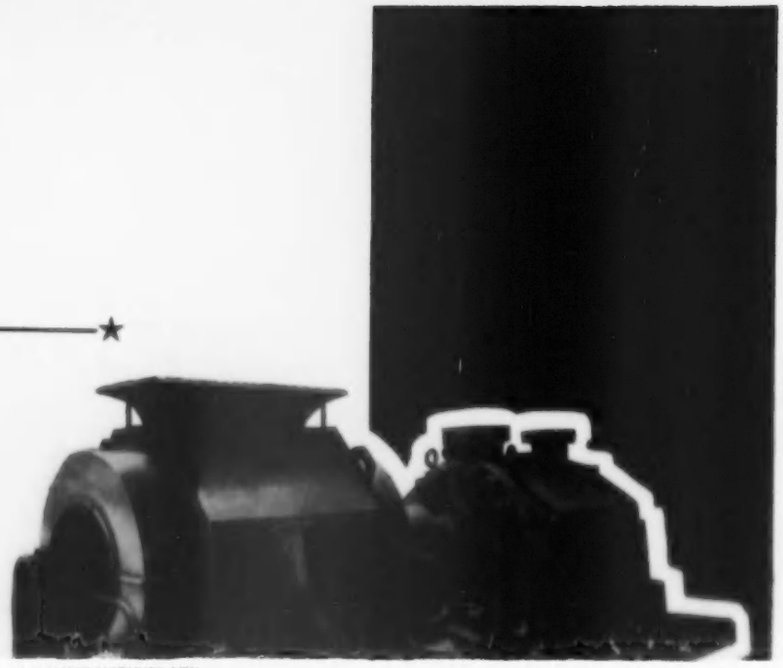




CAMBRIAN
WAGON & ENGINEERING CO. LTD.
MAINDY · CARDIFF
Telephone: Cardiff 29611 (6 lines) Telegrams: Wagons, Cardiff.

For 50 years CAMBRIAN have been building wagons to a very high standard, specialising in heavy-duty types for mineral transport and similar purposes. The Company's works are equipped with modern plant for producing in quantity all-steel, aluminium topped and timber wagons of all types as well as tank wagons and mine and quarry cars. Laminated springs for all types of locomotives and rolling stock are supplied to British and overseas railways and to leading wagon builders and repairers.

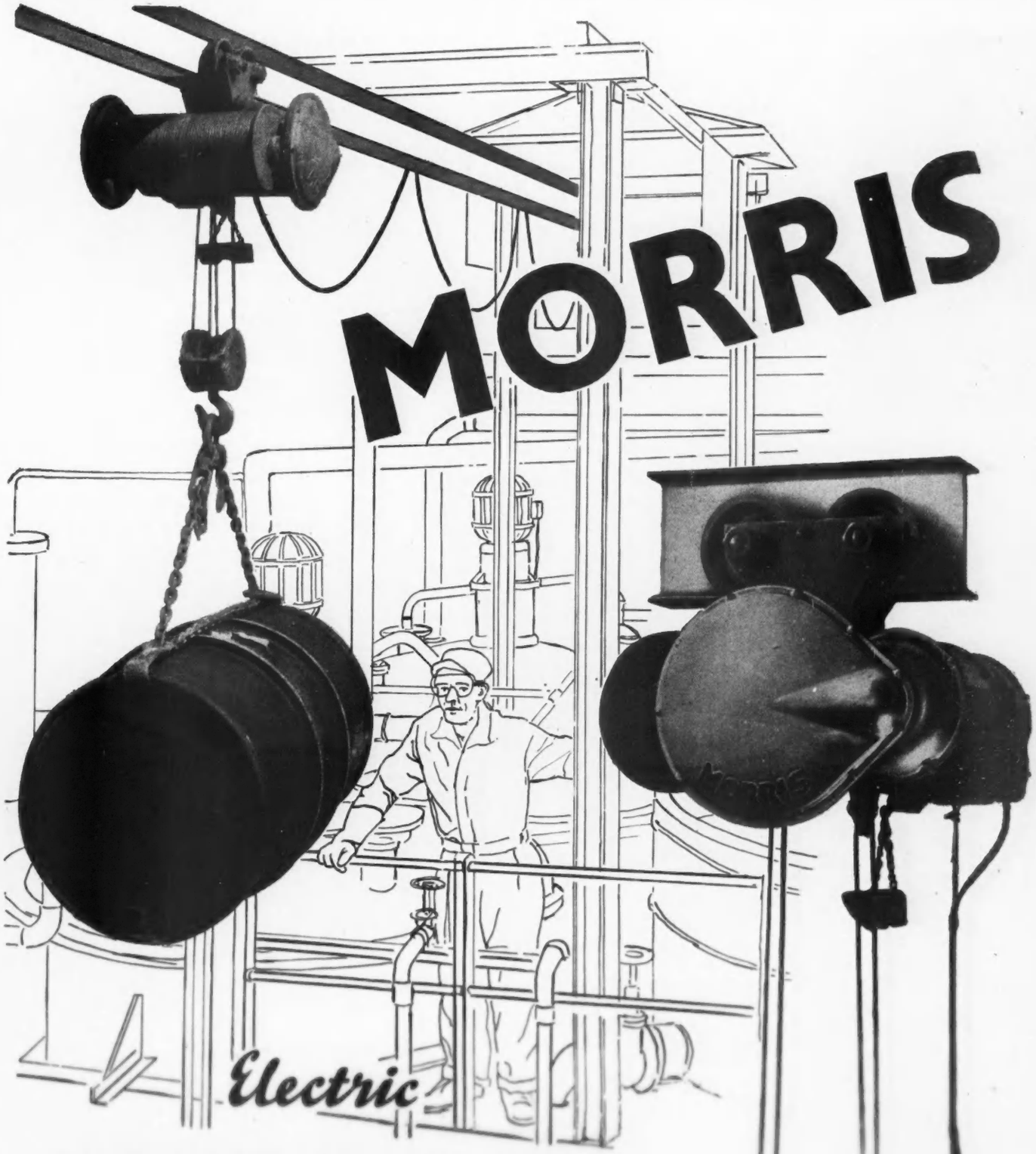
Pumping Sets for Power Stations



A Mather and Platt drip-proof squirrel-cage motor driving a boiler feed pump in a Central Electricity Generating Board generating station. It is rated at 1350 b.h.p., 2965 r.p.m., 3300 v., and is direct-on started with a low starting current. The Mather and Platt Plurovane pump delivers 600,000 lb. of feed water per hour at 260° F and 1210 lbs. sq in.

TOWER CONSTRUCTIONS LTD.

RICHARDSONS WESTGARTH (HARTLEPOOL) LTD., HARTLEPOOL, Co. DURHAM
and at: 58 Victoria Street, London, S.W.1. · 59 Mosley Street, Manchester, 2 · 75 Buchanan Street, Glasgow, C.1.



J. V. Gawards Ltd

Euston Road, on,
[illegible] 3771 (4 lines) Telegrams: Bescotools Norwest London

Lansdowne House, 41 Water Street, Birmingham, 3
Telephones: CENtral 7606/8 Telegrams: Bescotools Birmingham 3

Photograph by courtesy of Aston Chain & Hook Co. Ltd.

NOTHING TO LOSE?

But your chains...

. . . are vital links in the manufacturing process. Always difficult to lubricate, chains are sometimes run dry for lack of a satisfactory lubricant. Then there really is something to lose: frequent maintenance or replacement means loss of production. The answer is dry film lubrication the Acheson way. The chains in the photograph convey heavy drums of copper wire through an annealing furnace. It is essential that there should be no fumes or carbonaceous deposits from the chain lubricant, otherwise the wire would be spoiled. Because cleanliness is essential in this application, the company has used for many years 'Aquadag'* colloidal graphite in water. The result is maximum efficiency from the minimum of maintenance and labour. The product is simply brushed on the links once a week. Although it is used sparingly to prevent the drums slipping and upsetting the timing sequence, 'Aquadag' provides full lubrication.

*Registered trade mark of Acheson Industries (Europe) Ltd., licensed user—Acheson Colloids Ltd.

dag dispersions **speed** production

REGD. TRADE MARK

ACHESON COLLOIDS LIMITED

Subsidiary of Acheson Industries (Europe) Ltd.

PRINCE ROCK · PLYMOUTH · DEVON

Enquiries to: TECHNICAL SALES AND SERVICE · 70 Hill Street · Richmond · Surrey · *Telephone:* RIChmond 5481 (3 lines)

Also Acheson Colloids Company, Port Huron, Michigan U.S.A., and Acheson Colloiden N.V., Scheemda, (Gr.), Netherlands

RUBBER AND SYNTHETIC UNITS

(to any specification)

IN

NATURAL, NEOPRENE SYNTHETICS

GASKETS, OIL SEALS, SHOCK UNITS

WHEELS, RUBBERISED CORK, SPONGE

PLASTIC FOAM RUBBER

SAM KAY RUBBER CO. LTD.

HOPE MILL · PORTWOOD PLACE · STOCKPORT

TELEPHONE: STO 2617/8

G·CLANCEY LTD.

CASTINGS

for

ALL TRADES

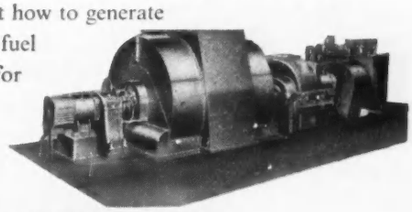
G·CLANCEY LTD.

BELLE VALE·HALESOWEN

TELEPHONE: CRADLEY HEATH · 69411 - 2 - 3

"...and it pays for itself in 5 years"

The increasing number of BRUSH Axial-Flow Turbines now being installed in steam-using industries is positive proof of their claim to pay for themselves in a very short time. If you use steam for space heating or processing and would like to know more about how to generate your own Power and improve your fuel efficiency, write to BRUSH asking for Publication No. 6f012/AD.



BRUSH

AXIAL FLOW TURBINES

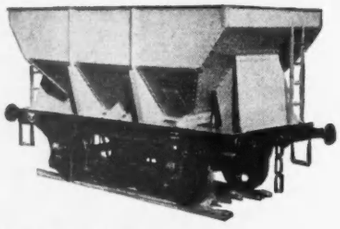
the logical choice

BRUSH ELECTRICAL ENGINEERING CO · LTD

Loughborough · England *(Member of the Hawker Siddeley Group)*

AT 1

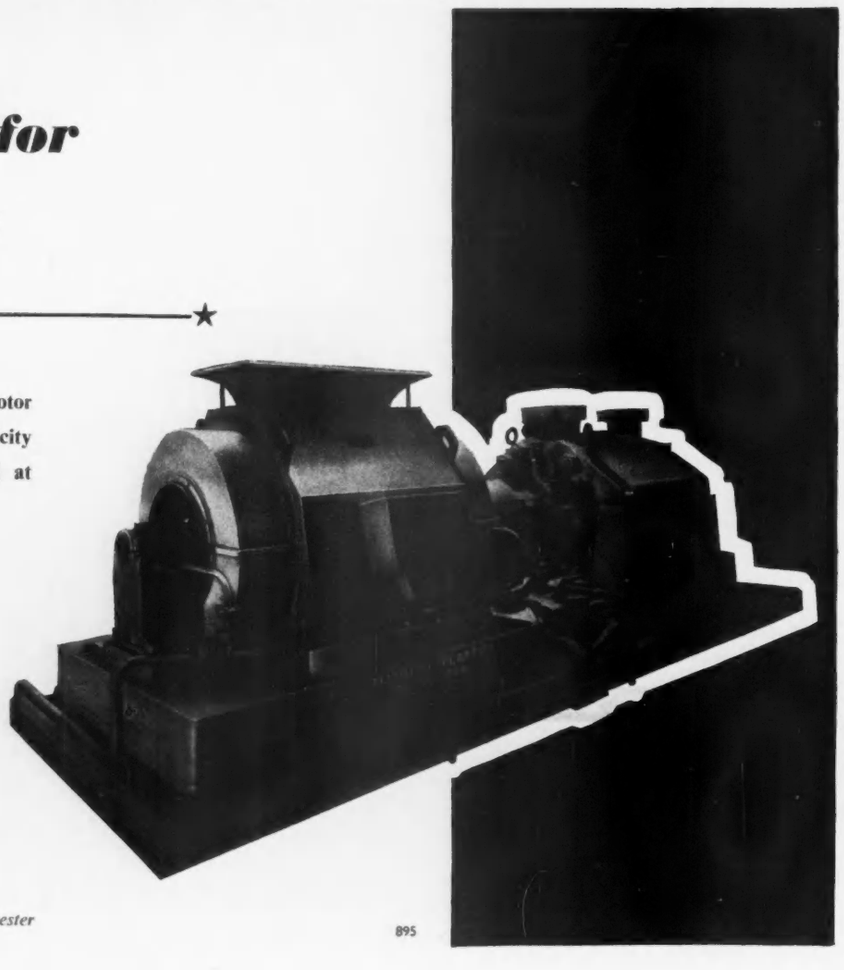
Cambrian rolling stock



CAMBRIAN
WAGON & ENGINEERING CO. LTD.
MAINDY · CARDIFF
Telephone: Cardiff 29611 (6 lines) *Telegrams: Wagons, Cardiff.*

For 50 years CAMBRIAN have been building wagons to a very high standard, specialising in heavy-duty types for mineral transport and similar purposes. The Company's works are equipped with modern plant for producing in quantity all-steel, aluminium topped and timber wagons of all types as well as tank wagons and mine and quarry cars. Laminated springs for all types of locomotives and rolling stock are supplied to British and overseas railways and to leading wagon builders and repairers.

Pumping Sets for Power Stations



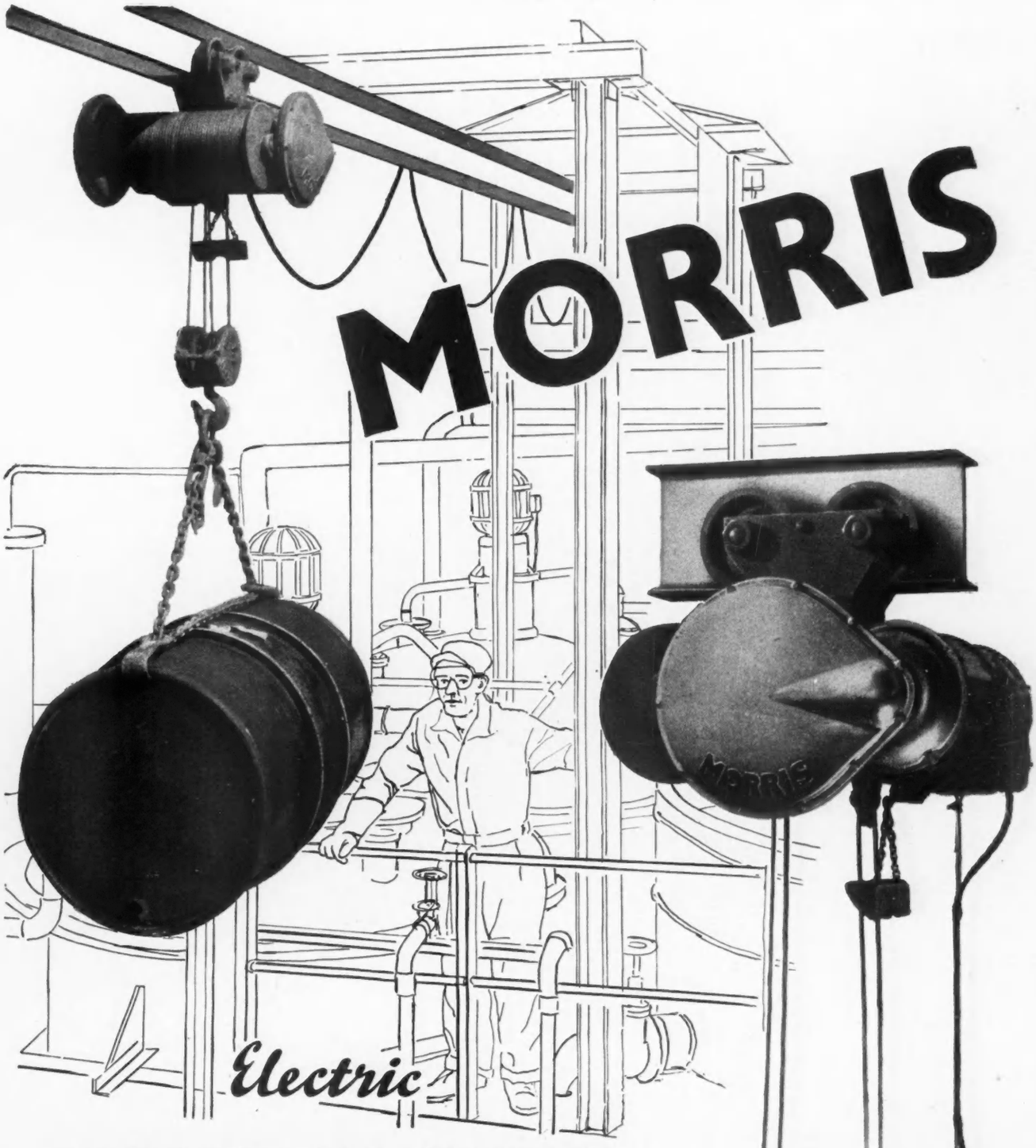
A Mather and Platt drip-proof squirrel-cage motor driving a boiler feed pump in a Central Electricity Generating Board generating station. It is rated at 1350 b.h.p., 2965 r.p.m., 3300 v., and is direct-on started with a low starting current. The Mather and Platt Plurovane pump delivers 600,000 lb. of feed water per hour at 260° F and 1210 lbs./sq. in.

Mather & Platt
LIMITED

PARK WORKS · MANCHESTER 10

Telephone: COLlyhurst 2321 *Telegrams: Mather, Manchester*

895



HOIST-BLOCKS

for LIFTING and MOVING

For many industrial lifting and moving jobs, Morris electric hoist-blocks (in one or other of the types listed below) fulfil requirements successfully and economically. Consider the comprehensive and adaptable Morris range. Push travel (as illustrated). Geared travel (moved by pulling on an endless hand-chain). Flexible bogie types (push or geared travel) for runways with curves. Electric travelling types for either straight or curved runways. Dual speed models with alternative lifting and lowering speeds in addition to normal speeds in one unit adaptable to the same form of suspension and travelling detailed above. **Sizes ¼, ½, 1, 2, 3, 5, 7½ and 10 tons.**

Twenty page Section 73 gives more details.

HERBERT MORRIS LTD P.O. Box 7 LOUGHBOROUGH ENGLAND.

TELEPHONE LOUGHBOROUGH 3123

Indicating r.p.m. of electric motor.

Indicating shaft speed, showing use of extension.

Indicating surface speed.

The Right REVS

Run your machinery at the optimum speed for peak efficiency. Any deviation from this speed almost certainly means that it—and you!—are running at a loss.

Cut this loss by making spot checks of r.p.m. with a SMITHS Hand Tachometer. Such a check can be made in an instant, even in unfavourable conditions. What's more, the reading is accurate to within ½%.

ATH 6

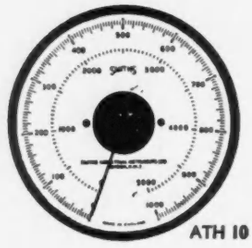
PRICE

(complete with strong case and full range of accessories)

£14.14.0

postage and packing extra.

ATH 7



ATH 10

SMITHS HAND TACHOMETERS
can be used for checking:—

Rotational speeds of shafts, spindles, gears, rotors and rolls.

Linear speeds in ft/min or metres/min of metal strips, textiles, paper, wire, plastic, film and conveyed material.

Surface speeds in ft/min or metres/min of cutting or grinding operations of machine tools, processing rolls, unwind rolls or wind up rolls for extrusion and strip production.

Readings can be taken in bad lighting conditions or where the dial is visually obscured.

AVAILABLE IN CHOICE OF FOUR MODELS:

Model A.T.H.4 illustrated (0-50,000 r.p.m.)
Model A.T.H.6 dial illustrated (0-10,000 r.p.m.)
Model A.T.H.7 dial illustrated (0-20,000 r.p.m.)
Model A.T.H.10 dial illustrated (0-5,000 r.p.m.)

ALL FOR L.H. OR R.H. DIRECTION OF ROTATION.

POST THIS FOR FULL DETAILS

Please send full details of your HAND TACHOMETERS

NAME _____

ADDRESS _____

_____

_____

SMITHS INDUSTRIAL INSTRUMENT DIVISION

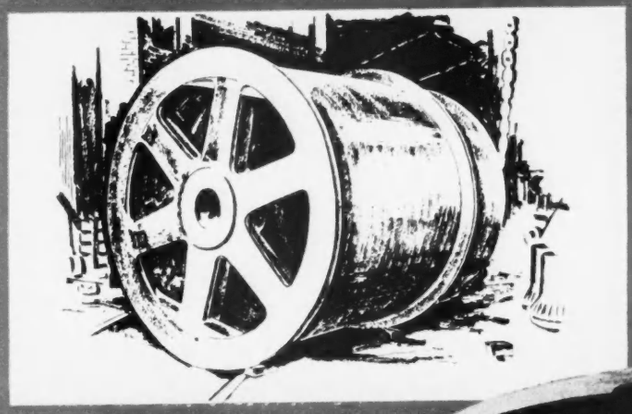
Chronos Works, North Circular Road, London, N.W.2. Telephone: GLAdstone 1136

IRON CASTINGS UP TO 20 TONS

ASHMORE'S GREY IRON AND HIGH DUTY IRON CASTINGS

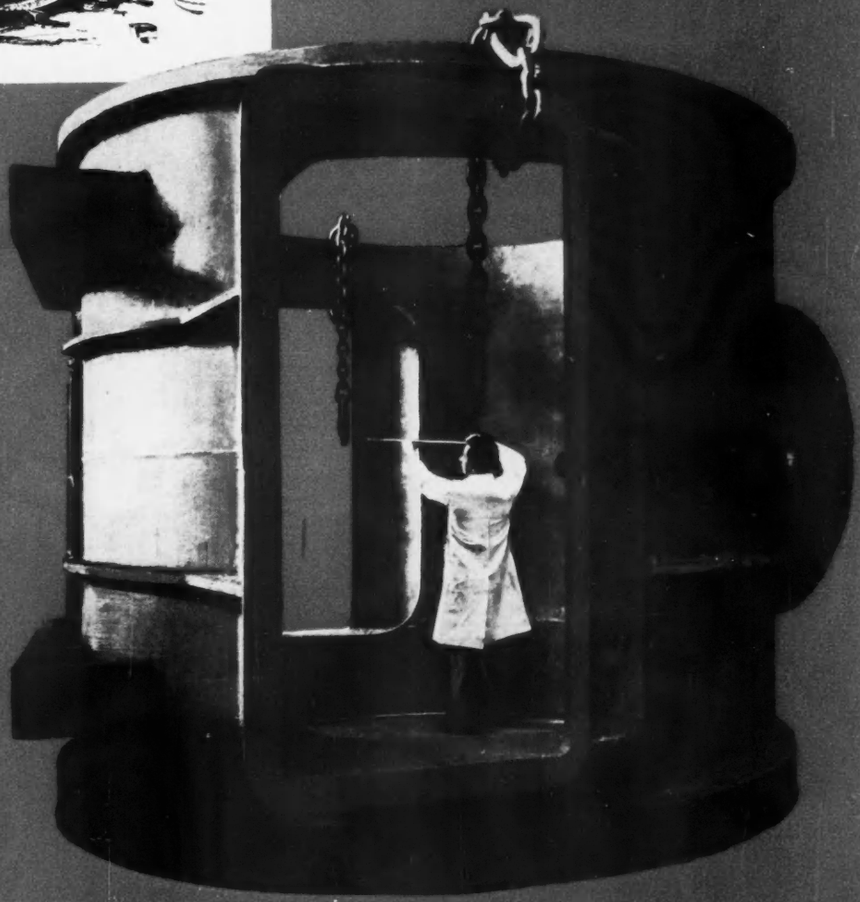
Ashmore's high duty iron castings are produced in many grades to meet specific requirements, whether for heat, wear or corrosion resisting applications and conform to B.S.S. 1452, grades 10-26. Capacity is available for producing castings up to 20 tons weight or 13 feet diameter, by modern methods and processes.

Moulds and cores are produced by hand and machine moulding and loam moulding in green sand, oil sand, sand slinger production and CO_2 processes.



Main winding rope drum for blast furnace equipment 10 tons in weight.

QUALITY AND SERVICE
ASHMORE'S IRON CASTINGS



A 13½ ton evaporator casing cast in high duty iron.

ASHMORE, BENSON, PEASE & CO

(MEMBER OF THE POWER-GAS GROUP)

STOCKTON-ON-TEES AND LONDON

373 AUSTRALIA · CANADA · INDIA · FRANCE · SOUTH AFRICA

BUILD YOUR EFFICIENCY WITH

OSBORN PRODUCTS

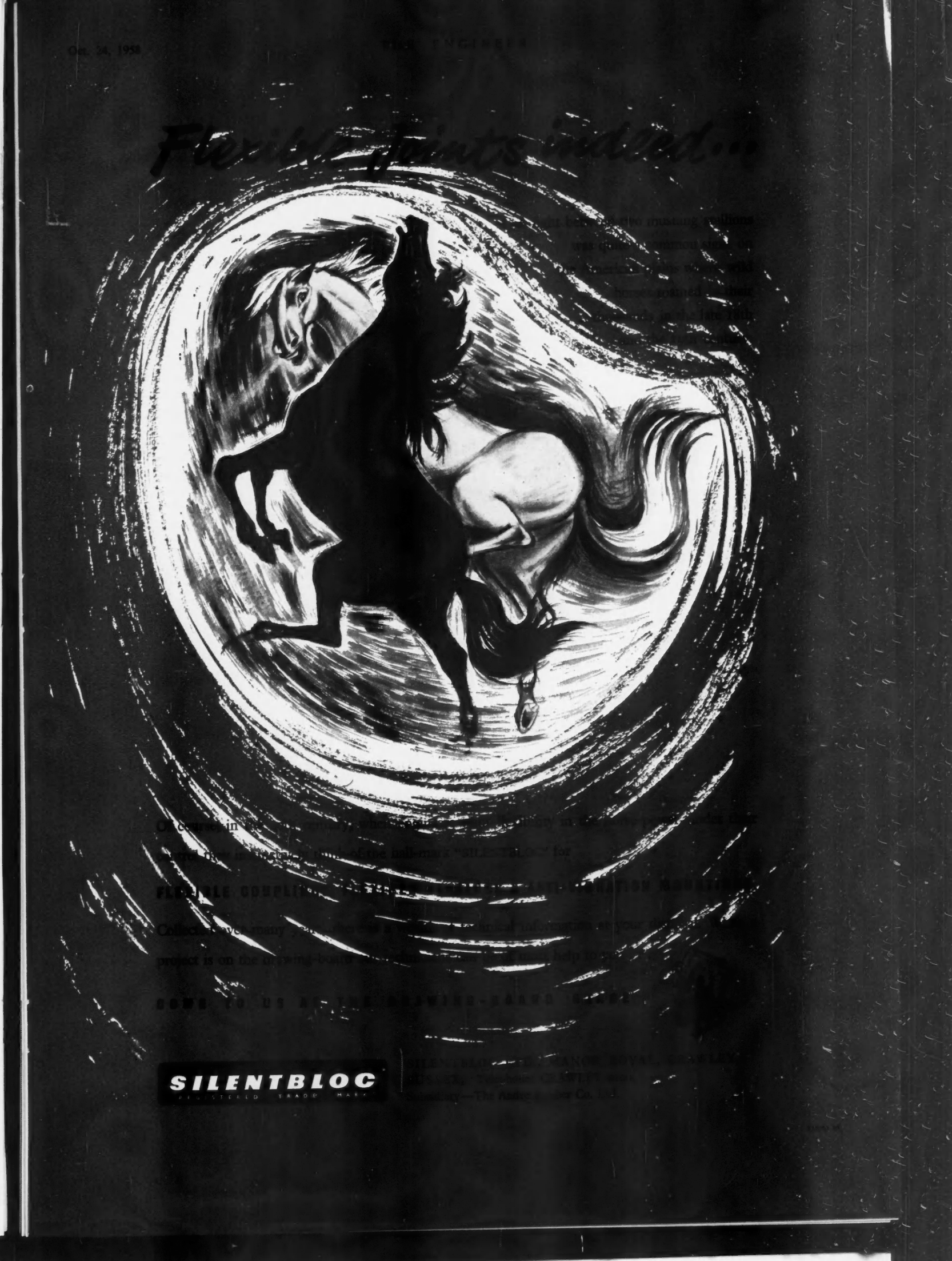
Integrated experience from over a century of craftsmanship has made the name of *Osborn* world famous as a hallmark of quality in the manufacture of fine steels and steel products.

Products in alloy, stainless and tool steels are manufactured throughout within the same organisation, and include castings by general foundry and precision methods, forgings and engineers' cutting tools etc.

STEELMAKERS · STEELFOUNDERS · ENGINEERS' TOOLMAKERS

SAMUEL OSBORN & CO., LIMITED

CLYDE STEEL WORKS, SHEFFIELD


Flexibility is better
SILENTBLOC

Du Pont's 2 Chemical Rubbers—
Neoprene and Hypalon—are at your service

For extra durability and value to guarantee customer satisfaction with your rubber products, try Du Pont's neoprene and HYPALON.

Neoprene has high resistance to most causes of deterioration and will withstand rugged conditions. HYPALON has extra high ozone resistance; high colour stability; withstands high temperatures. Your distributor will gladly give you further information. Send coupon for "Du Pont Elastomers Notebook", showing new ways elastomers save money.

For more information about locally manufactured products made of Du Pont neoprene and Hypalon, write:

Distributors DU PONT COMPANY (UNITED KINGDOM) LTD.,
76 JERMYN STREET, LONDON, S.W.1
Sales Agents DURHAM RAW MATERIALS LTD.,
131 GREAT TOWER STREET, LONDON, E.C.3

DU PONT

Better Things for Better Living . . . through Chemistry

E. I. du Pont de Nemours & Co. (Inc.)
Room D-2070-P Du Pont Building,
Wilmington 98, Delaware, U.S.A.

NAME.....
POSITION.....
COMPANY.....
ADDRESS.....
CITY..... COUNTRY.....

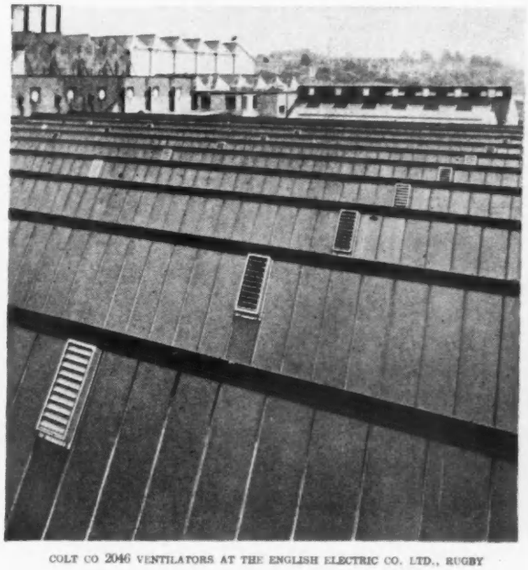
32 contracts from the English Electric Co. Ltd endorse the supremacy of

COLT

VENTILATION

Time and again, industrialists large and small place repeat orders with Colt. And for three good reasons. Colt ventilation systems depend in the main on internal convection currents —*not* external forces—and are therefore little affected by the vagaries of the wind. Colt offer an unparalleled range of ventilators. And most important, every Colt recommendation is based on a thorough analysis of the building, plant and process either from a site survey or drawings. Such thoroughness influences firms such as the English Electric Co. Ltd. It will impress you, too.

Ask your secretary to send for a free manual to Dept. S29/10B



COLT CO 2046 VENTILATORS AT THE ENGLISH ELECTRIC CO. LTD., RUGBY

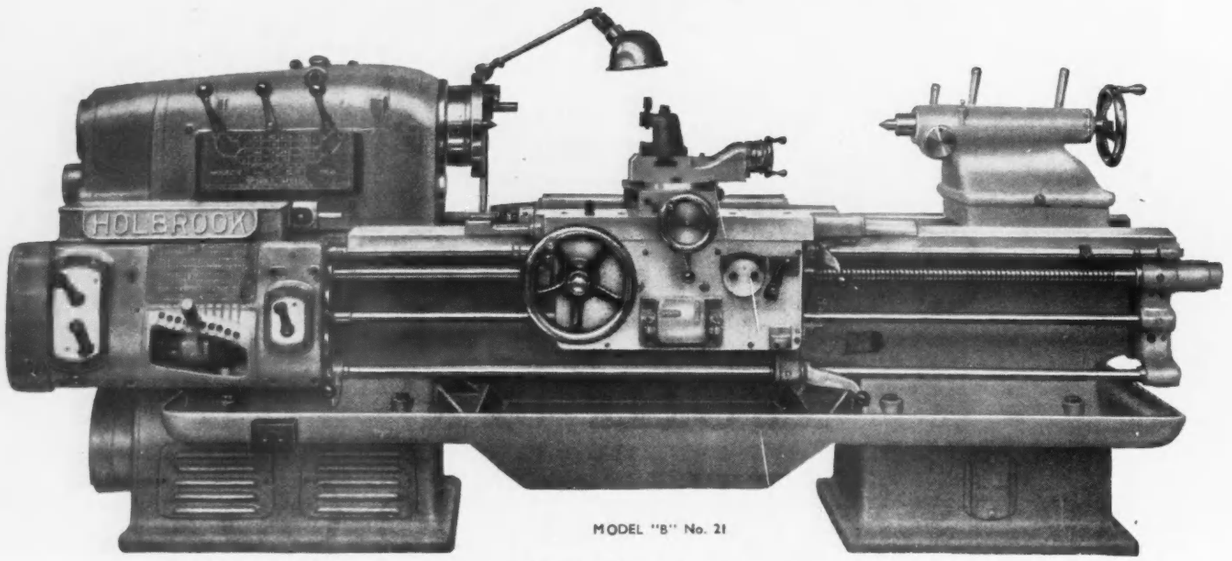
Among the 12,000 major Industrial Organisations using Colt equipment are:

15 contracts:	*Cow & Gate Ltd.*
20 contracts:	*Courtaulds Ltd.*
37 contracts:	*Vickers-Armstrongs (Aircraft) Ltd.*
11 contracts:	*The Steel Company of Wales Ltd.*
15 contracts:	*United Kingdom Atomic Energy Authority*
6 contracts:	*Smith-Clayton Forge Ltd.*
29 contracts:	*National Coal Board*
22 contracts:	*Lever Bros. Port Sunlight Ltd.*
14 contracts:	*Bristol Aircraft Co. Ltd.*
17 contracts:	*Davey Paxman & Co. Ltd.*
15 contracts:	*S.P.D. Ltd.*
25 contracts:	*British Oxygen Co. Ltd.*
15 contracts:	*Dorman Long & Co. Ltd.*
12 contracts:	*English Steel Corporation Ltd.*
14 contracts:	*Ferranti Ltd.*
16 contracts:	*General Motors Ltd.*
11 contracts:	*Thomas Hedley & Co. Ltd.*
15 contracts:	*Hoover Ltd.*
9 contracts:	*Joseph Lucas Ltd.*
19 contracts:	*Philips Electrical Industries Ltd.*
21 contracts:	*The Plessey Co. Ltd.*
20 contracts:	*Ruston & Hornsby Ltd.*

COLT VENTILATION LIMITED • SURBITON • SURREY • TELEPHONE: ELMBRIDGE 0161 (10 LINES)

C

STRATFORD **Holbrook** LONDON



MODEL "B" No. 21

PRECISION TOOL-ROOM LATHES

MODEL "B"

BUILT IN THREE SIZES SWINGING 13-17-21 INCHES OVER BEDWAYS

The Finest Lathe in its Class

WHAT, PAY FOR PEST CONTROL? *I use a gun!*

Did you hear about the time he winged the man from the Tax Office? There was a certain amount of fuss because he didn't have a Licence, so he called us in to cope with the rats and mice, which we are doing very efficiently to the great relief of everyone involved—except the rats and mice. Our pest destruction service is Safe and Sure ; if your premises are infested, call us in NOW.

B. L. & N. PHILLIPS LTD.

Vermin Destroyers

124 SOUTHWARK STREET, LONDON, S.E.1. Telephone WATerloo 5546

BIRMINGHAM : 208 County Chambers, 66½ Corporation Street. Tel : Central 1176

BRISTOL : Swan House, 112 Hotwell Road, 8. Tel.: Bristol 20512 Ext. 5

EXETER : 21 Church Lane, Sidwell Street. Tel.: Exeter 54181

EDINBURGH : Pesticidal Services (Scotland) Ltd., 34 Bernard Street, Leith, 6 Tel.: Leith 38393

GLASGOW : Pesticidal Services, (Scotland) Ltd., 93 Waterloo Street, Tel.: City 0735

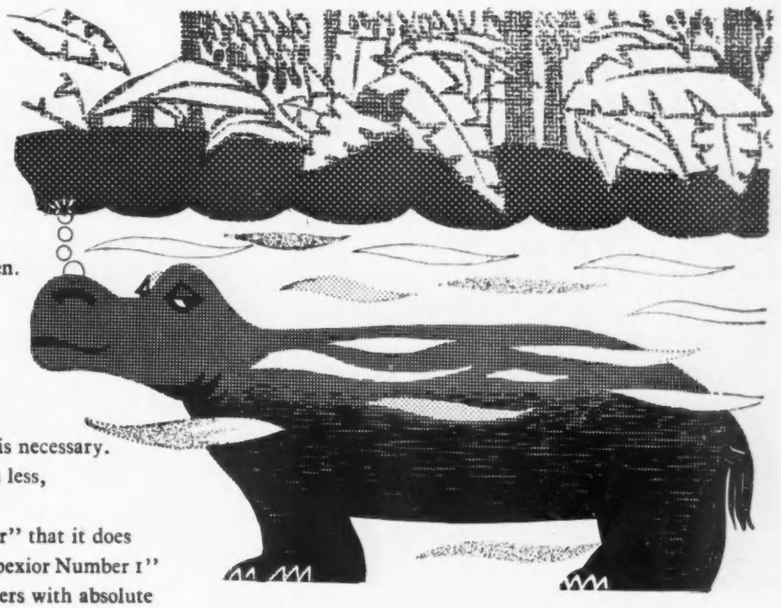
SOUTHAMPTON : 14 Howard Road. Shirley. Tel.: Southampton 25307

LEEDS : 21 Upper Mill Hill. Tel.: Leeds 2-5266

LIVERPOOL : 8a Rumford Place, 3. Tel.: Central 2068

BELFAST : Pesticidal Services (Ireland) Ltd., 153 Upper North Street. Tel.: Belfast 26998

He would merely submerge and forget



Unfortunately corrosion in steam-raising plant cannot be forgotten. It is too costly and damaging in its effects.
"Apexior Number 1" is the most economical, *sure* safeguard against corrosion on surfaces in contact with wet temperatures between 175° and 1000°F. Two coats of "Apexior Number 1"—mechanically or brush applied—constitute absolute protection for at least 12 months. After the initial treatment only one coat is necessary. Subsequent descaling is a much simplified process because scale is less, looser and more easily removed from Apexiorised surfaces.
In certain industries it is a most important advantage of "Apexior" that it does not affect the water by taste, taint or smell. For over 50 years, "Apexior Number 1" has been put to work in all types of boilers of leading manufacturers with absolute satisfaction. Let experience be *your* guide; send for a copy of the "Apexior Manual".

DAMPNEY'S APEXIOR REGISTERED

"APEXIOR NUMBER 1" PREVENTS CORROSION IN STEAM-RAISING PLANT

But for cold-wet surfaces up to 125°F.—use "APEXIOR NUMBER 3"

BRITISH PAINTS LIMITED
APEXIOR DIVISION
PORTLAND ROAD, NEWCASTLE UPON TYNE, 2.
CREWE HOUSE, CURZON STREET, LONDON, W.1.
31, WAPPING, LIVERPOOL, 1.

SYDNEY · ADELAIDE · TORONTO · DURBAN · CAPE TOWN
CALCUTTA · TRINIDAD · NEW YORK · ARKLOW
Our world-wide service is at your disposal for the asking

BPL/A.34

A Barimar Achievement
"To Crow About!"

Here is a recent repair of which Barimar are mighty proud. It was a scientific welding job in which every moment counted, for many thousands of pounds of productive work for the British Motor Industry was at stake.

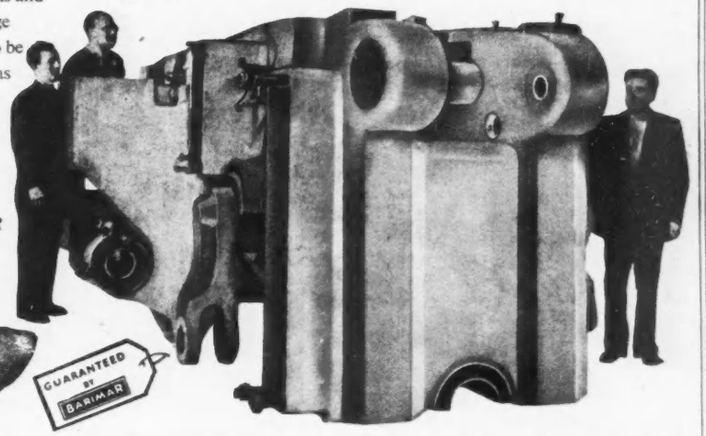
The pictures tell a vivid story of the repair of the crown of a mighty power press that stamps out tens of thousands of body panels and other components for the motor industry in Great Britain every year. This press crown weighed twenty tons and the damage that had to be repaired was grievous.

TWENTY tons or TWENTY questions BARIMAR supplies the Answers!

As the top picture shows, the four heavy toggle-shaft lugs were broken right away. The repair of each lug was the kind of poser that Barimar experts delight to tackle and solve. There were also serious cracks and fractures in the main body of this huge casting and twenty-five feet of cracks and fractures had to be welded in metal up to 7 ins. thick. Throughout, the job called for superlative welding—Barimar Scientific Welding that stands up to tremendous strain.

The other picture shows the completed job. The four lugs were lined up so accurately before welding that subsequent machining was reduced to a minimum. As the crown was ready for service again within record time, the owners' losses on production were reduced to the lowest possible level. Only Barimar could have tackled an outsize job like this—only Barimar could have returned the repair to the owners with the famous Barimar Money-back Guarantee.

ALL BROKEN PARTS which are transportable must be sent CARRIAGE PAID or delivered to the nearest Barimar Branch. Please remove all fittings, and post letter advising dispatch. When it is impossible to transport the damaged machinery, Barimar experts will operate ON THE SPOT!



IF IT'S SCIENTIFIC WELDING YOU'RE AFTER—CONTACT

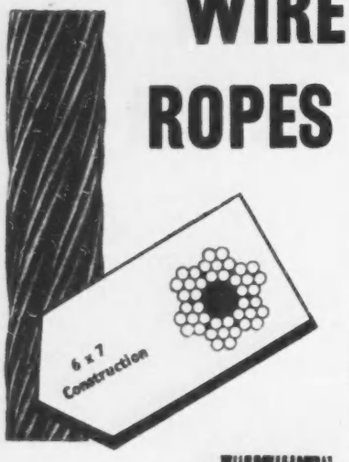
BARIMAR LTD.
Barimar House,
22-24, Peterborough Road,
FULHAM, LONDON, S.W.6.

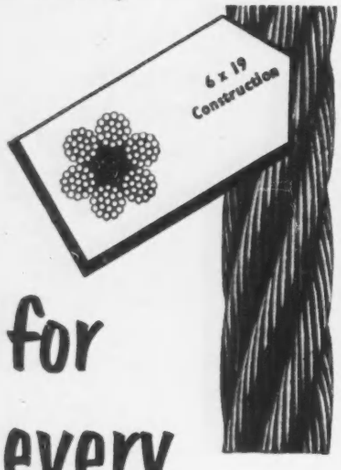
Telephones: RENown 2147–2148. (Night) 2148.
Telegrams: "Bariquamar, Walgreen, London."

Branch Addresses: BIRMINGHAM, 12: 116–117, Charles Henry St. *Telephone: Midland* 2696. NEWCASTLE UPON TYNE, 1: 64–66, The Close. *Telephone:* 21055. MANCHESTER, 13: 67, Brunswick Street, Ardwick. *Telephone: Ardwick* 2738. GLASGOW, C.2: 134, West George Lane. *Telephone: Central* 4709

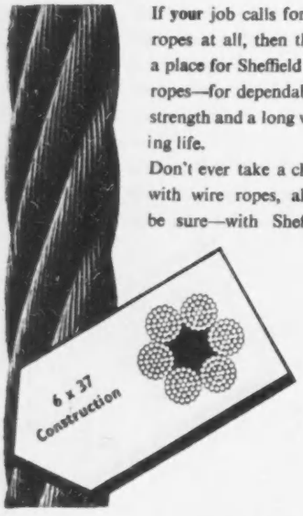
BARIMAR—THE WORLD'S SCIENTIFIC WELDING ENGINEERS

SHEFFIELD WIRE ROPES





for every purpose



If your job calls for wire ropes at all, then there's a place for Sheffield Wire ropes—for dependability, strength and a long working life.

Don't ever take a chance with wire ropes, always be sure—with Sheffield.

Also makers of the "RAM" RAILWAY WAGON PINCH BAR.

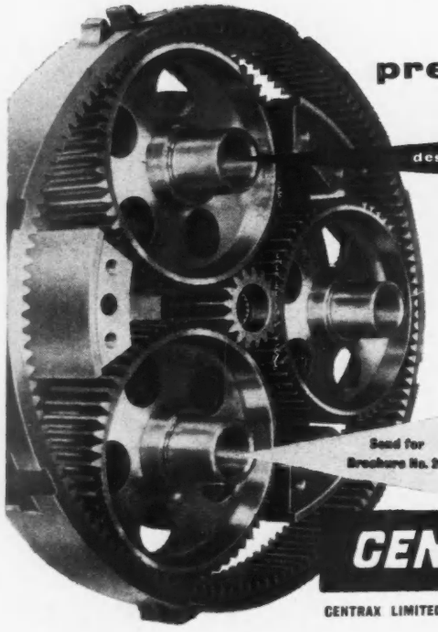
THE SHEFFIELD WIRE ROPE CO. LTD.
DARNALL, SHEFFIELD, ENGLAND

PIRELLI-GENERAL CABLES

More than equal to the extra service demanded

ORDER FROM THE G.E.C.

The General Electric Co. Ltd., Magnet House, Kingsway, London, W.C.2

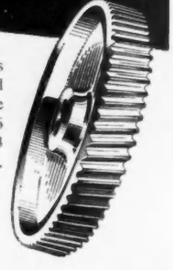


precision ground gears

design and manufacture of complete gear boxes

helical and spur
gears up to 12" diameter in prototype
or production quantities

a range of precision ground case-hardened gears



Where it is possible to use pre-designed gears quick delivery can be made from the range of 6 diametral pitches with 3 helix angles or in straight spur.

Send for Brochure No. 20

CENTRAX

CENTRAX LIMITED, VICTORIA ROAD, FELTHAM, MIDDLESEX Telephone: FELtham 4851-5
Cables: Centrax, Feltham

THE EVENT we have in mind is here, all substance and no shadow.
An entirely new Spirax steam trap, working on the revolutionary but well-tested thermodynamic principle.
Wholly British in its patented design and construction, it is a formidable and attractive addition to the steam-user's armament.

THE SPIRAX THERMODYNAMIC TRAP:

- is small in size and weight, and has *only one operating part.*
- is made only of stainless steel.
- works up to 550°F and from 10–350 psi *without adjustment.*
- is unaffected by superheat, waterhammer, vibration and corrosive condensate.
- needs no condensate seal or prime.
- is easily maintained when (very rarely) necessary. Freezing causes no damage.

Steam users will want to know more of a steam trap which is so simple, robust, efficient and economical. The completed request slip will see to that.

Spirax-Sarco Ltd

Please post full details of the brand-new Spirax Thermodynamic Steam Trap.

NAME

ADDRESS

EG1058

Spirax-Sarco Ltd. Cheltenham, Glos. Phone: Cheltenham 5175-76
London: 28 Victoria Street, SW1 Abbey 6101-3832

NOW MAINTENANCE

IS *PREVENTIVE* . . .

So Breakdowns Need Never Occur

New Visual System Gives Warning of Inspection Dates

How can you keep your plant running at full pressure ? How can you *organise* maintenance so that each machine is serviced *before* it breaks down, and not *after ?*

To these vital questions, the new system of preventive maintenance now gives a 100% answer.

How ? Firstly by providing a colour-signal "alarm system" which actually pre-warns of forthcoming inspection dates. Secondly, by keeping you in the picture with every detail you must know about each and every machine.

This is achieved by means of a simple visible card system which instantly shows :

1. Full technical details of all equipment (description, H.P., drive, etc.).
2. Complete maintenance history ; inspections made, repairs, overhauls.
3. Automatic reminders of important dates, i.e. inspection and overhauls.
4. Speedy, visible reference to location of equipment, number, type, etc.

This means an end to all those production losses — often substantial ones — formerly caused by defective machinery. Also, you pinpoint uneconomical plant ; and ensure that machines run permanently at full productive pressure.

But can the system be adapted to *any* organisation — even the smaller one ? Indeed it can ! Although originally conceived for one of the largest machinery users in the Country, it is now gaining currency in concerns of all sizes, including the smaller, privately-owned factory.

If you would like to know more about this system for control of plant and machinery (which, incidentally, saves a considerable amount of clerical labour !) why not get details today ? All you have to do is write "Preventive Maintenance" on your letterheading and post to the address below.

SHANNON
Trade Mark

Shannon Systems

O & M TO BRITISH BUSINESS

THE SHANNON LTD.,
87 Shannon Corner, New Malden, Surrey
Branches throughout the Country

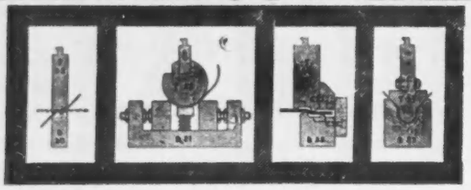
144

L. ROBINSON & CO. (GILLINGHAM) LTD., LONDON CHAMBERS, GILLINGHAM, KENT. TEL. 5282

BRONX

PRESS BRAKES AND PRESS BRAKE TOOLS

● For forming sections in all metals, in all thicknesses, up to 20ft. wide — Bronx Press Brakes are faster and more versatile than folding machines and can be tooled for punching, shearing and notching. Of exceptionally massive design and construction — with guaranteed unbreakable fabricated solid steel frame — an outstanding advantage is their ability to take heavy overloads at bottom of stroke without deflecting the frame. Range of sizes from 20 to 1,000 tons pressure.

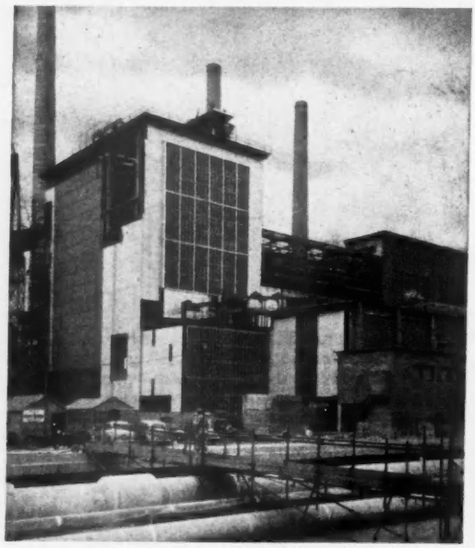


No matter what make of Press Brake you use, our FREE TOOL SERVICE is at your disposal. Please send for our explanatory leaflet. Large stocks of tools are held for immediate despatch

BRONX ENGINEERING CO. LTD., LYE, WORCS. *Telephone LYE 2307 & 2308*

LONDON & S. OF ENGLAND AGENTS: W. E. Norton (Machine Tools) Limited
Grosvenor Gardens House, Grosvenor Gardens, London, S.W.1 TATe Gallery 0633/4

BRITAINS BIGGEST BOILER



. . . on an industrial site in this country . . .

INSULATED BY

Main power plant at the Wilton works of Imperial Chemical Industries Limited. Boiler installation by Babcock and Wilcox Ltd., and insulated by Newalls under contract to Babcock and Wilcox Ltd.

Newalls

NEWALLS INSULATION CO. LTD.
Head Office: WASHINGTON, CO. DURHAM.
A Member of the TURNER & NEWALL ORGANISATION

Offices & Depots at: LONDON, GLASGOW, MANCHESTER, NEWCASTLE UPON TYNE, BIRMINGHAM, BELFAST, BRISTOL AND CARDIFF. *Agents and vendors in most markets abroad.*

OVERHEAD · TRAVELLERS · ELECTRIC GOLIATH

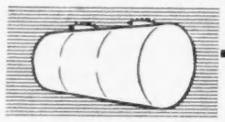
LOCOSTEAM OVER HEAD

EST 1870

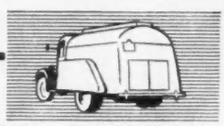
MARSHALL FLEMING CRANES

DELLBURN WORKS MOTHERWELL · SCOTLAND
Telephone: Motherwell 50 Telegrams: "Dellburn" Motherwell

LOCO STEAM · ELECTRIC GOLIATH · TRAVELLER

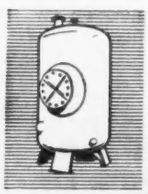


M.S.L
Electrically Welded

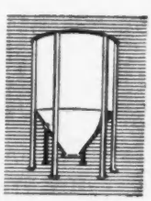


STORAGE & TRANSPORT TANKS

As supplied to all Ministries, Principal Oil Companies & Petrol Pump Manufacturers
For every storage and transport purpose. Steel Horizontal Tanks, Cylindrical Underground Tanks, Fuel Oil Tanks, Road Wagon Tanks, Rectangular Tanks, Air Receivers, Vats, Hoppers, etc.
When ordering specify M.S.L.



25 Years experience in Fabricated Arc-Welding Construction



Write for full particulars to :—
METAL STRUCTURES, LTD.
Angel Factory Colony, Angel Rd., Edmonton, N.18
Phone: Edmonton 6601/2/3 Grams: Metstru, Southtot, London.

NON-FERROUS CASTINGS of every type -

No matter whether your requirements are for a few castings weighing up to 2 tons or more, or for repetition batches, we can meet all your requirements for quality, price and delivery. We cast in all usual alloys including phosphor bronze, gun metal, aluminium bronze and manganese bronze, "Monel" metal etc. Send us your enquiries.

It pays to Consult

CHARLES CARR LTD.
Incorporating THE NON-FERROUS CASTING CO. (BIRMH.) LTD.
GROVE LANE · SMETHWICK 40 · BIRMINGHAM
TEL: SMETHWICK 1231-2-3

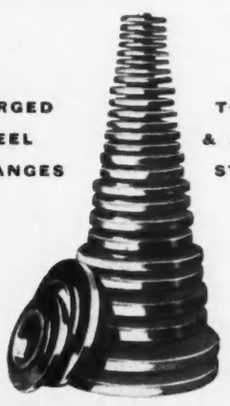
LONDON OFFICE—
56 HOLBORN VIADUCT, E.C.1. CITY 3836-7

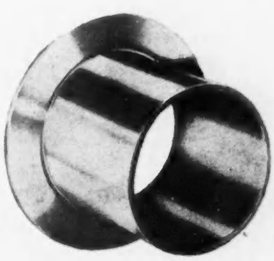
ENGINEERS!

buy from

KIRKS-

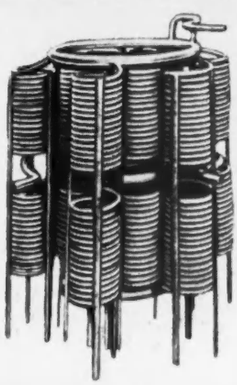
FORGED STEEL FLANGES TO BRITISH & AMERICAN STANDARDS





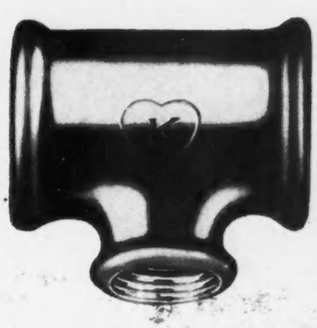
STAINLESS STEEL STUB NIPPLES

FABRICATED PIPEWORK IN STEEL, STAINLESS STEEL AND COPPER



K

THE HEART OF RELIABILITY



MALLEABLE TUBE FITTINGS

...and you **BUY BRITISH!**

KIRK & CO (TUBES) LTD

74-82 PARADISE ST., LONDON, S.E.16
BERMONDSEY 3156 7-8
WALSALL MANCHESTER PONTYCLUN

—as British as the Flag

Follsain-Wycliffe
FOUNDRIES LTD

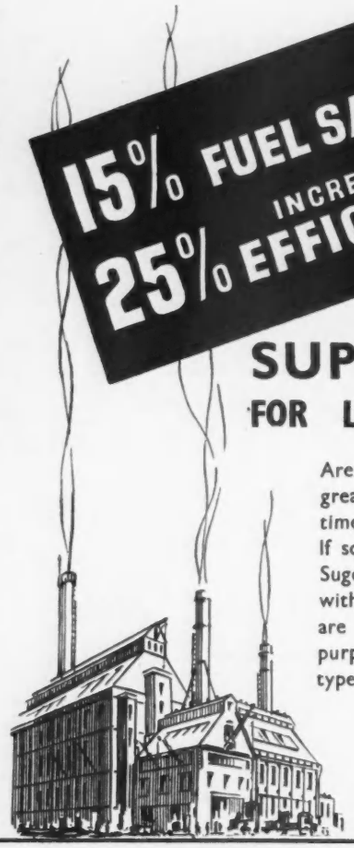
The
SPECIALIST FOUNDRY
for
BLACKHEART MALLEABLE IRON
and
HEAT & ABRASION RESISTING ALLOY CASTINGS
for
Automobiles and commercial Vehicles
Gas, Electricity and Steel Undertakings
Mining and Quarrying Plant
Cement, Brick, Pipe and Tile Works
Heat Treatment Plants
together with many others

CASTINGS SUPPLIED AS CAST OR FULLY MACHINED

Manufacturers of 'PULMAC' Pulverising Mills for Fine Grinding

FOLLSAIN-WYCLIFFE FOUNDRIES LTD
Lutterworth, nr. Rugby. Tel: Lutterworth 10, 60 & 152
Grams: Wycliffe, Lutterworth

15% FUEL SAVING
25% INCREASE IN EFFICIENCY

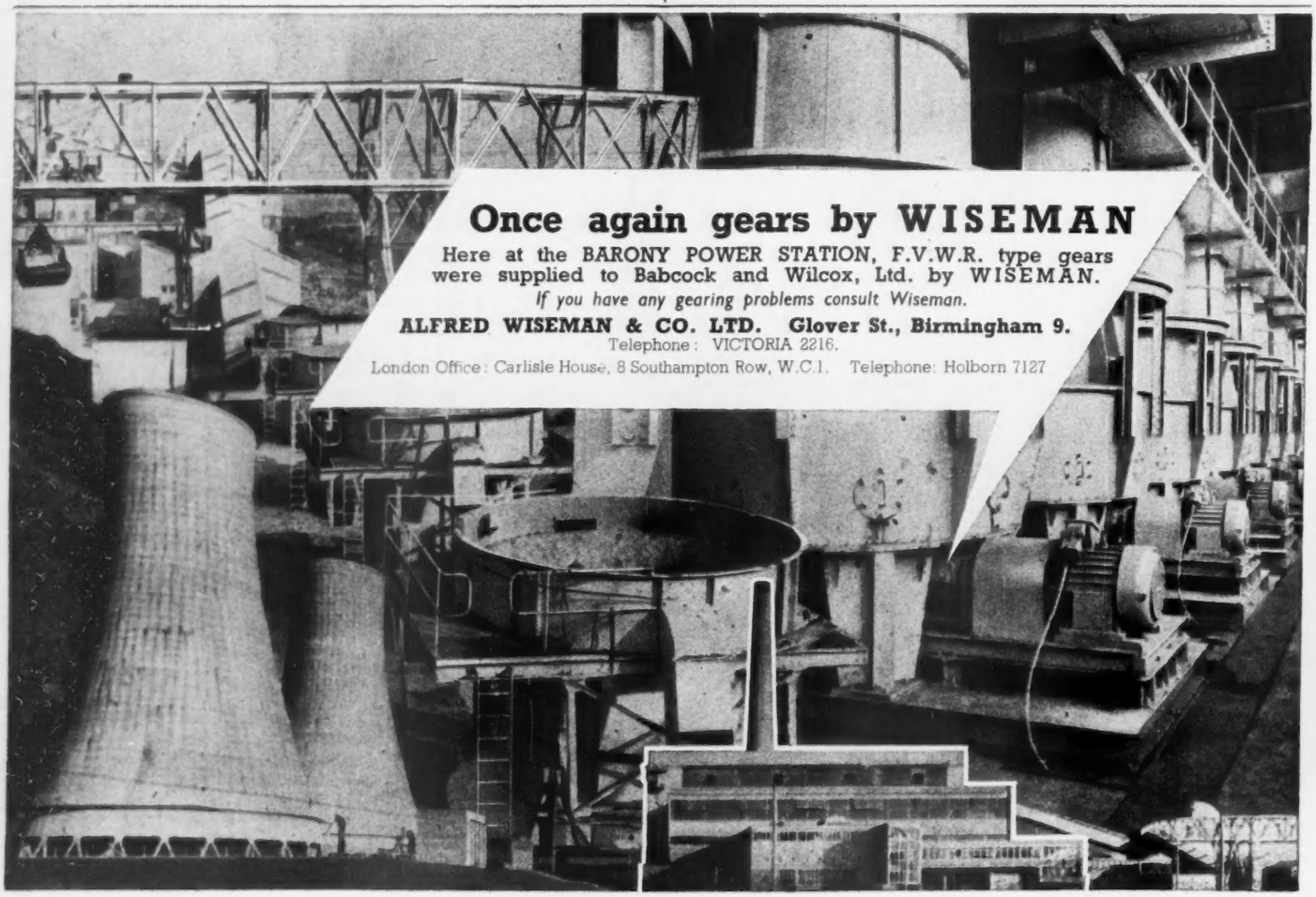


SUPERHEATERS FOR LANCASHIRE BOILERS

Are you interested in getting greater efficiency and, at the same time, saving on your fuel costs? If so we invite you to consult us. Sugden Superheaters can be fitted with full damper control. They are suitable for all industrial purposes and can be fitted to all types of Shell boilers.

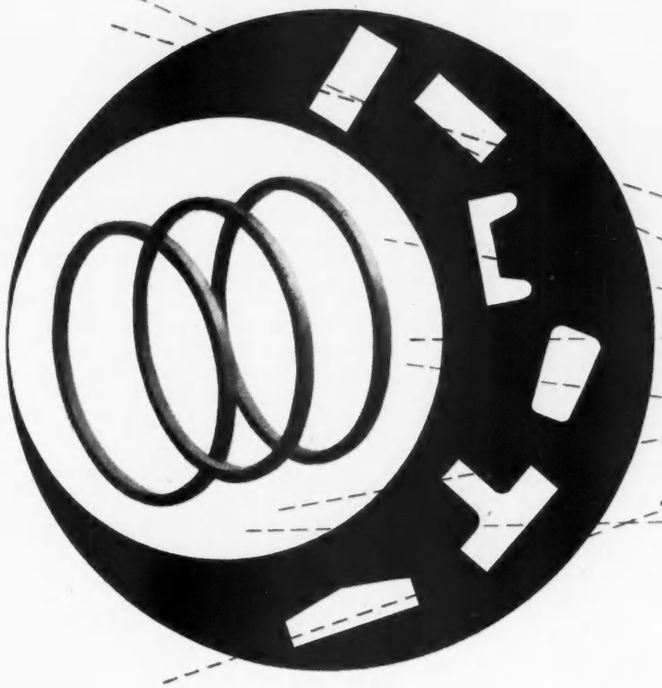
Sugden Superheaters are of particular value where auxiliary steam boilers are used.

T. SUGDEN LIMITED
MOSLEY ROAD, TRAFFORD PARK, MANCHESTER 17
Telephone: TRAFFORD PARK 2520



Once again gears by WISEMAN
Here at the BARONY POWER STATION, F.V.W.R. type gears were supplied to Babcock and Wilcox, Ltd. by WISEMAN.
If you have any gearing problems consult Wiseman.
ALFRED WISEMAN & CO. LTD. Glover St., Birmingham 9.
Telephone: VICTORIA 2216.
London Office: Carlisle House, 8 Southampton Row, W.C.1. Telephone: Holborn 7127

RINGS

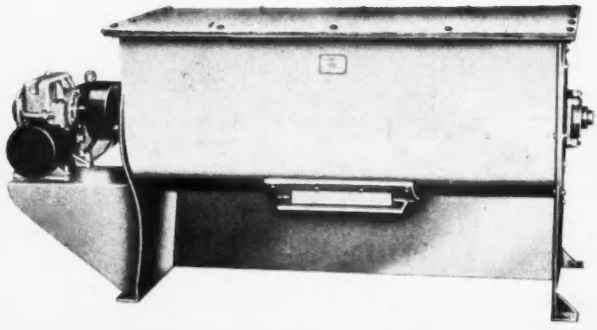


FORGED AND WELDLESS ROLLED TO SECTIONS OR PROFILE

..... made in carbon and alloy steels, weldless and flash-butt welded. Also Rings produced from the ' NIMONIC ' alloys, Titanium, light alloys or copper bearing materials.

N. HINGLEY & SONS LTD
NETHERTON IRON WORKS
FORGE DIVISION — DUDLEY

TEL: DUDLEY 3101-6 - GRAMS: HINGLEY DUDLEY



HORIZONTAL MIXER

THIS MODERN HORIZONTAL MIXER GIVES THE MOST ACCURATE PREMIX OF SUPPLEMENTS AND FEED STUFFS AVAILABLE FROM LABORATORY SIZES UP TO 3 TONS CAPACITY

W. S. BARRON & SON LTD.
GLOUCESTER

Manufacturers with over 50 Years' experience — Offer the latest in
CRUSHING · GRINDING · MIXING
FEEDING · SIEVING
MACHINERY

The most practical way of Elevating bulk material

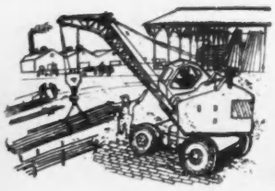
COMPACT · ECONOMICAL
TROUBLE-FREE

1 to 50 tons per hour Capacities

Screw-Lift

PATENTED AND TRADE MARK REG. U.S. PAT. OFF.

Phone: Gloucester 21055-6-7



FORD
POWER
for industry

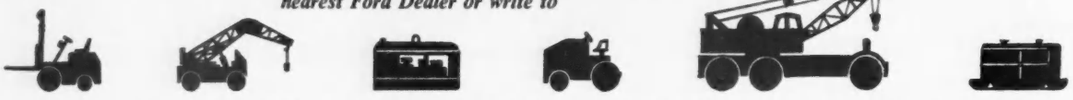
Ford industrial engines are a practical proposition for many industrial equipments **... compressors, cranes, pumps, contracting equipment, earth borers, generators, railcars, welding plant, works trucks, tractors and conversions.** Simple design, modern flow-line production methods and common interchangeable parts contribute to the low cost of these high efficiency engines. And remember, *every* Ford engine is fully backed by a World-wide Spare Parts Service Organisation. Take your choice from a wide power range... Diesel 30 to 86 b.h.p. and Petrol 21 to 87 b.h.p. (12-hr. rating).

DIESEL ECONOMY—have you considered the replacement of existing power units in your equipment and trucks with the famous Ford 4D Diesel engine? You'll have the unique advantages of economy, long-life and low running costs... plus the best service in the World!

Wherever you are, whatever your problem, we are at your service. For further details of

FORD INDUSTRIAL ENGINES

and the equipments they power, contact your nearest Ford Dealer or write to

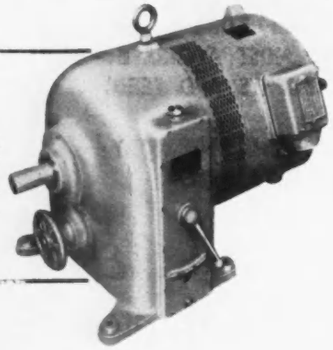


FORD MOTOR COMPANY LTD · PARTS DIVISION · AVELEY DEPOT · SOUTH OCKENDON · ROMFORD · ESSEX · ENGLAND

Examples from our range of VARIABLE SPEED GEAR UNITS AND SPEED REDUCERS

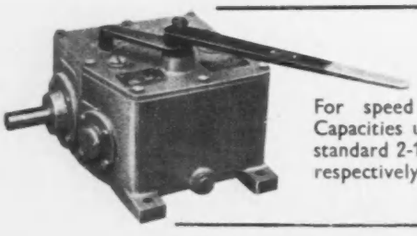
MULTIPLE SPEED GEARBOXES

With co-axial shafts, capacities 5, 15, 35 h.p., overall ratios from 1-1 up to 7-1. Two, three or four speeds. Motorised or non-motorised.



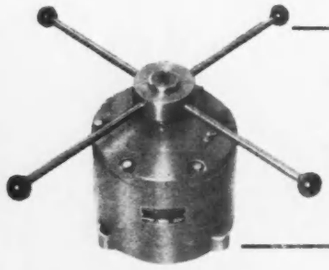
"STRATELINE" SPEED-REDUCER

Horizontal foot-mounted, universal flange-mounted. Single, double or triple stage. Motorised or non-motorised. Co-axial shafts. Ratios up to 10,000 to 1. Output torque up to 64,000 lb. in.



VARATIO POSITIVE VARIABLE SPEED GEARS

For speed changing under power. Capacities up to 45 h.p. Overall ratios, standard 2-1, 3-1, 4-1 in 7, 9, 13 speeds respectively. Spur gear, co-axial drives.



VALVE AND WINCH OPERATING GEAR

Co-axial shafts. Flange mounting. Developed for individual applications. Hand or power operation.

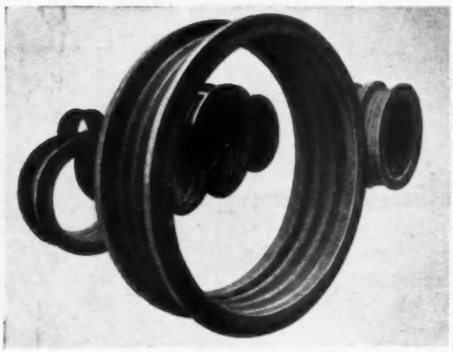
Special units developed to customers' requirements

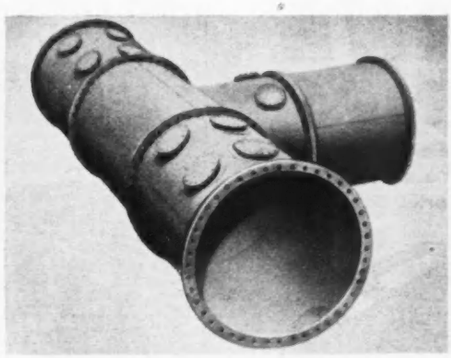
Write for further details:-

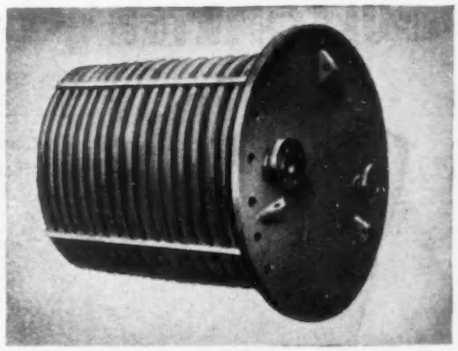
VARATIO-STRATELINE GEARS LTD.

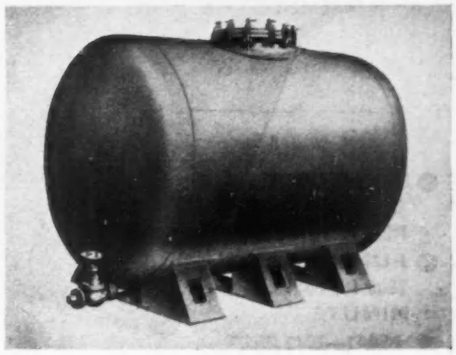
277-279 Aberdeen Ave., Trading Estate, Slough, Bucks

Telephone : Slough 20271/2. Telegrams : Varatio, Slough.









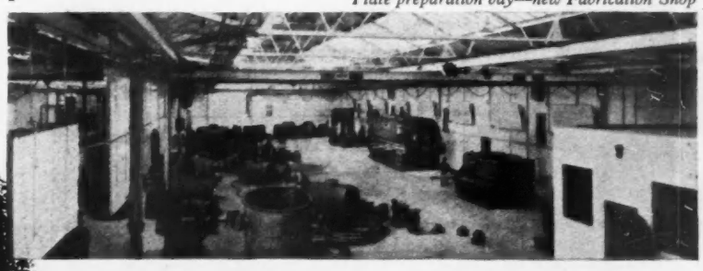
Clarks of Hull now design and fabricate in Stainless Steel, Mild Steel, Aluminium, etc.

QUICKLY, ECONOMICALLY AND EFFICIENTLY

After leading the field for over a hundred years in the fabrication of copper vessels, expansion joints, etc. Clarks of Hull have now—to cater for fabrications in stainless steel, mild steel, aluminium, etc. —erected a completely new Fabrication Shop. Newly-equipped with the most modern processes and staffed with hand-picked, highly-experienced personnel, Clarks' Fabrication Shop is in a position to combine excellent deliveries with high standards of workmanship —probably giving you more for your money too! A skilled design service is available.

- **Metallic Arc Welding**
- **Argonaut and Argon-Arc Welding**
- **Stress-relieving and testing facilities**
- **Agents or representatives in all parts of the country**

Plate preparation bay—new Fabrication Shop



CLARK

FOR EVERY TYPE OF WELDED FABRICATION

GEORGE CLARK & SONS (HULL) LIMITED
HAWTHORN AVENUE · HULL
Telephone: 37654 Telegrams:"Clark, Hull"

BCA

A MEMBER OF THE NEWMAN HENDER GROUP

PULSOMETER MINE PUMPS

- One of a large range supplied to all parts of the World.
- RATED FOR 1334 GALLONS PER MINUTE
- RUNNING AT 1500 REVS. PER MINUTE
- HEAD—2570 FEET
- HIGHEST EFFICIENCIES
- Several Designs made for Hydraulic Power Installations and many other purposes.

Please send enquiries to:—

PULSOMETER ENGINEERING CO. LTD.
NINE ELMS IRONWORKS, READING

London Office: Pulsometer House, 20/26, Lamb's Conduit Street, W.C.1.

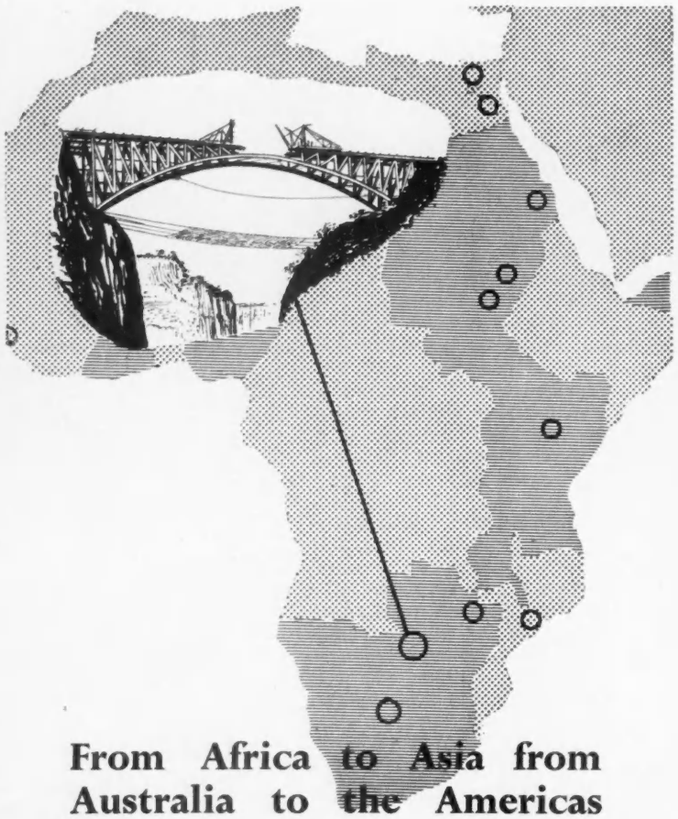
WHERE THERE'S A **RUGGED** JOB...

THERE'S EVERY REASON FOR

Manufactured by: SINTERED PRODUCTS LTD. Sutton-in-Ashfield, Notts

Sole Distributors: **SMALL & PARKES LTD**
HENDHAM VALE WORKS · MANCHESTER 9 · COLLYHURST 2511

London Office: 76 Victoria Street, S.W.1 · VICtoria 1845/6



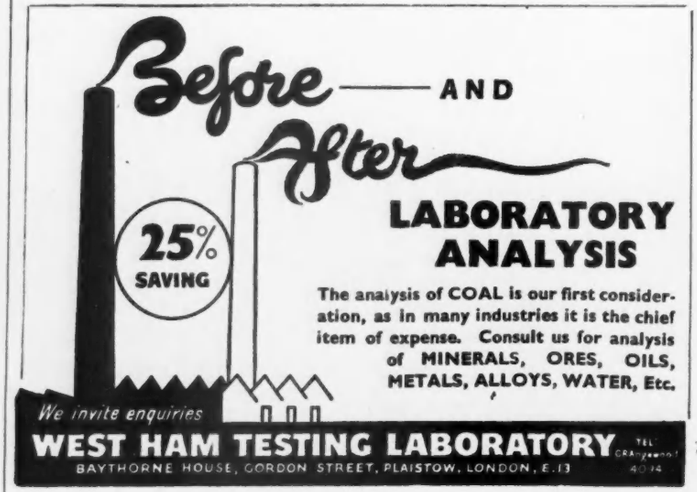
From Africa to Asia from Australia to the Americas you will find examples of Cleveland engineering skill

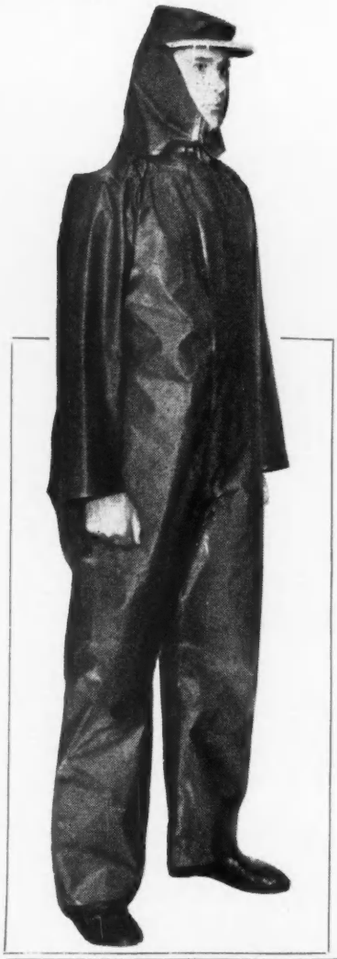
AN INVITATION Our services are always available in design, in detailing, and in the casting and construction of all types of structures.

CLEVELAND

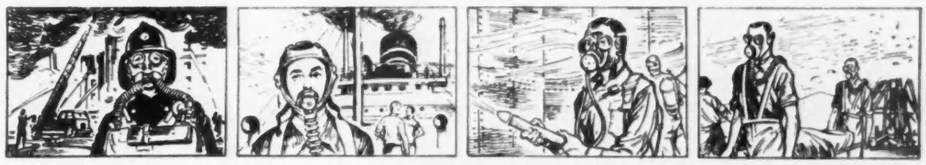
CONTRACTORS, BUILDERS OF BRIDGES AND CIVIL ENGINEERS

THE CLEVELAND BRIDGE & ENGINEERING CO. LTD. DARLINGTON


Before — AND
After
25% SAVING
LABORATORY ANALYSIS
The analysis of COAL is our first consideration, as in many industries it is the chief item of expense. Consult us for analysis of MINERALS, ORES, OILS, METALS, ALLOYS, WATER, Etc.
We invite enquiries
WEST HAM TESTING LABORATORY
BAYTHORNE HOUSE, GORDON STREET, PLAISTOW, LONDON, E.13



Whatever the hazard . . .



. . . it's safer with SIEBE, GORMAN

ESTABLISHED 1819

P.V.C. BOILER SUIT, CAP AND VISOR

This lightweight suit in P.V.C.-coated rayon is highly resistant to splashed acids, alkalis, oils and solvents. It therefore provides ideal protection for employees in the chemical industry and other 'wet' locations, whether hazardous or not. All seams are stitched and electronically welded, for great strength and durability. The sliding front fastening has an extended facing, firmly secured by press studs. Attached to the peak of the comfortably shaped cap is a plastic visor while protection for back of the head and neck is provided by a P.V.C.-coated rayon curtain sewn to the cap and fastened under the chin. Each item of this easily-cleaned outfit, including boots and gloves, can be supplied complete or separately. SIEBE, GORMAN are long-established suppliers of all types of safety equipment to the Admiralty, the Public Services and Industry.

NEPTUNE WORKS · DAVIS ROAD · CHESSINGTON · SURREY

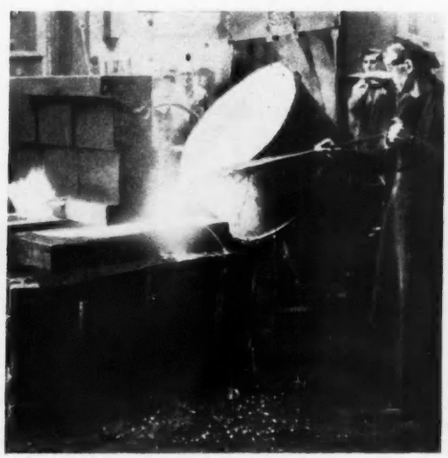
TELEGRAMS: SIEBE, CHESSINGTON. TELEPHONE: ELMBRIDGE 5900

Manchester Office: 274 Deansgate — Tel. Deansgate 6000

TGA T8

CASTINGS

prompt deliveries guaranteed



Owing to improved production facilities we are now in a position to offer prompt deliveries of the following types of grey iron castings:—

JOLTER AND SAND-SLINGER
Max. jolting weight, 3 tons. Max. box size, 6'x6'
Max. weight per casting, 10 to 30 cwt. approx.

FLOOR MOULDING
Capacity is available for all types of floor moulding including large cylinders, pipes and general jobbing work. Max. weight 3 tons approx.

HOLMES — FOUNDED 1850 — HUDDERSFIELD

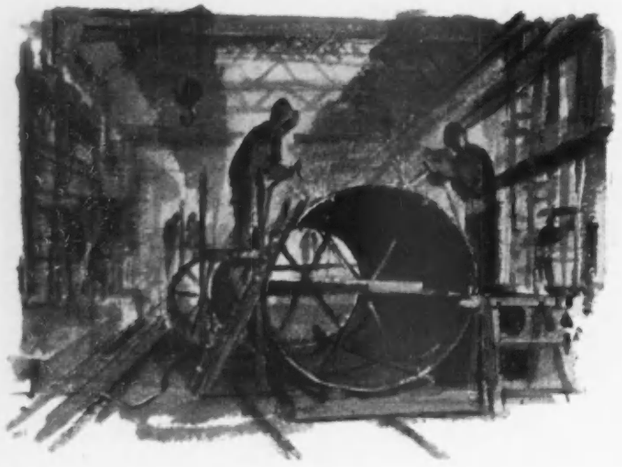
All enquiries will be given immediate attention.

W. C. HOLMES & CO. LTD.

HUDDERSFIELD, LONDON, BIRMINGHAM

Telephones: Huddersfield 5280.
Birmingham: Midland 6830 London: Victoria 9971

C9667



HAVE A WORD WITH WOOLSTON

After nearly a hundred years of building and repairing ships, there is not much we don't know about Engineering.
With the foundries and shops at our disposal we can carry out any engineering job from straightforward welding to the most complicated switchgear, from heavy castings to light plate work. If you want a "good engineering job"—**have a word with Woolston.**

THORNYCROFT

SHIPBUILDERS
MARINE ENGINEERS
SHIP REPAIRERS

★ *Write for a copy of S.E.B. 103—*
"Thornycroft Engineering Service to Industry"

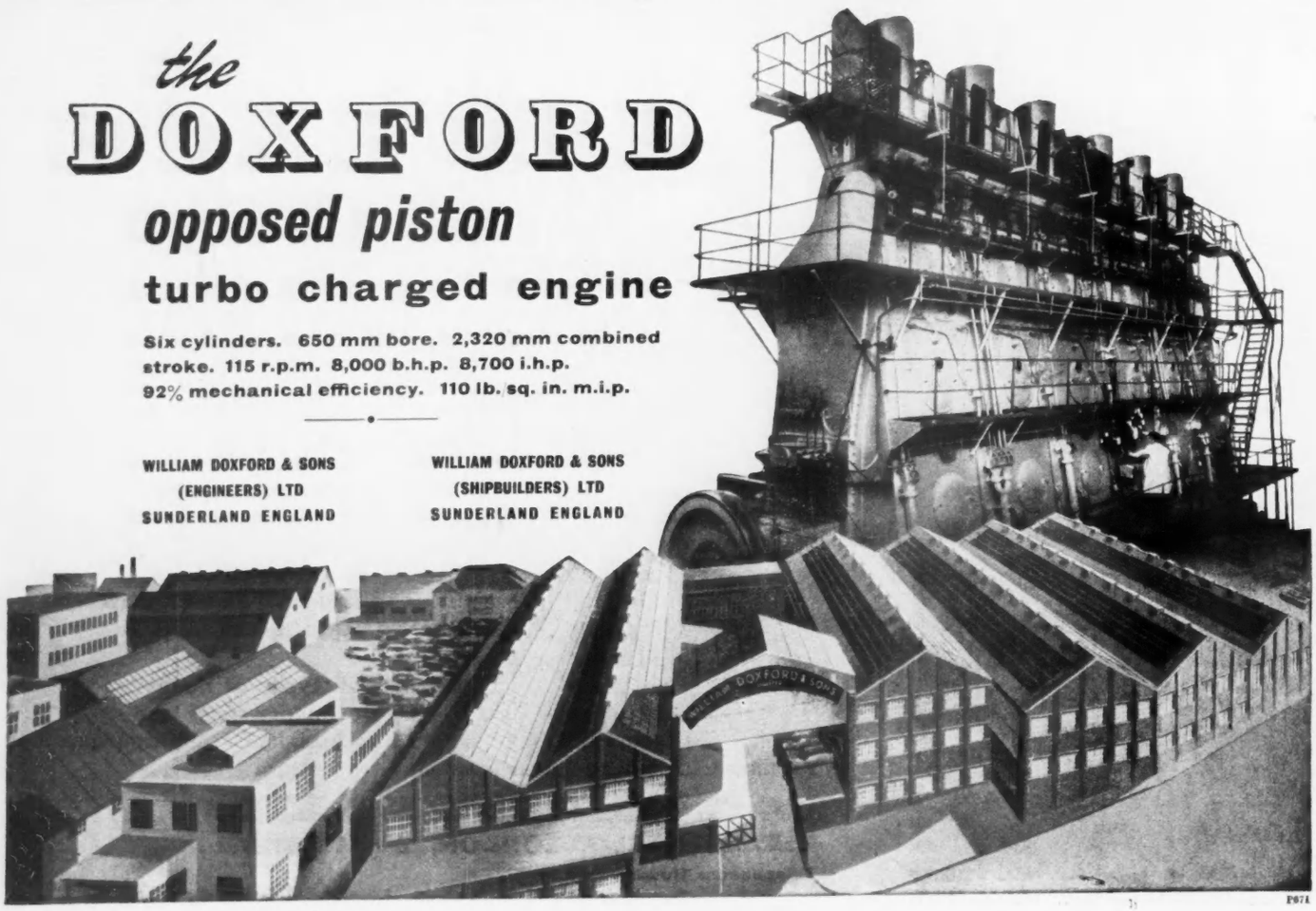
JOHN I. THORNYCROFT & CO. LIMITED, WOOLSTON WORKS, SOUTHAMPTON

the
DOXFORD
opposed piston
turbo charged engine

Six cylinders. 650 mm bore. 2,320 mm combined stroke. 115 r.p.m. 8,000 b.h.p. 8,700 i.h.p. 92% mechanical efficiency. 110 lb. sq. in. m.i.p.

WILLIAM DOXFORD & SONS (ENGINEERS) LTD SUNDERLAND ENGLAND

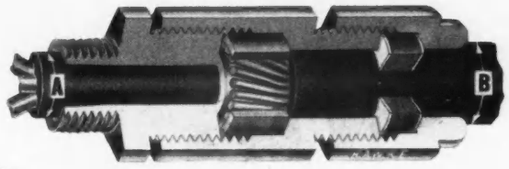
WILLIAM DOXFORD & SONS (SHIPBUILDERS) LTD SUNDERLAND ENGLAND



P971

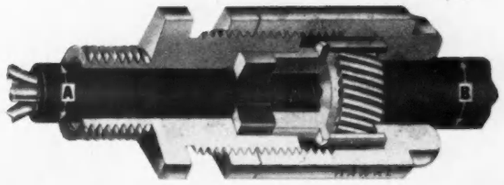
HAWKE *glands go round the world* *

Hawke Compression Type Glands and Sealing Boxes are used throughout the world. Recommended where armoured cables are used and where flameproof installations are required. Specified for oil Refineries, atomic power plants, and all hazardous areas. In regular use by Government Departments, the Central Electricity Authority, the National Coal Board, Chemical Industries, Oil Refineries and Steel Companies.



8/G3

G/11

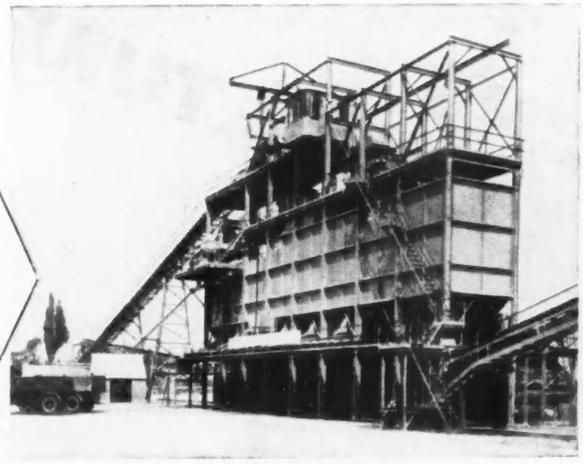


★ **DURGAPUR Steelworks, INDIA, has specified standard Hawke cable glands** (specially treated) **7/G3, 8/G3, 9/G3, G/11**

HAWKE CABLE GLANDS LTD.

Ashworth St., Denton, Manchester. Tel: DENton 3868/9. Telex: 66-135

This Modern Pit *Stops the Rot* with . . .



. . . BTR

WATERPROOF
CONVEYOR BELTING

This modern plant operated by Charlton Sand & Ballast Co. Ltd is equipped with every technical advance to make it efficient and economic in operation —and a contributory factor is the use of . . . BTR WATERPROOF CONVEYOR BELTING. BTR Waterproof Belting is on every conveyor in the pit. Charlton Sand & Ballast Co. Ltd selected it as a result of its outstanding performance in their other pits. BTR Waterproof belting is ideal for wet materials and watery conditions because its immunity to water is permanent—its fabric cannot rot, it cannot stretch and it does not prematurely fail: nor is it liable to mildew or to any kind of fungus attack. If you are operating under watery conditions fit BTR Waterproof belting for greater output and lower belt maintenance and renewal costs.

BTR

ENGINEERS IN RUBBER

BTR Industries Ltd

BRITISH THERMOPLASTICS & RUBBER MANUFACTURERS

HERGA HOUSE VINCENT SQUARE LONDON S.W.1

D2526

Consult

FILTON

for **ROTARY UNIONS**

(Patented)

USED ON AIR, STEAM, WATER, OIL &c. FOR LEAKPROOF FLUID TRANSFER TO ROTATING MACHINERY

SIZES ¼"—3" BSP

SPECIALS UP TO 6" BORE

FILTON LIMITED

Clapham Street, Leamington Spa, WARWICKSHIRE

Telephone Spa 8111/2

Increase production!

by using

SCRIVEN MACHINE TOOLS

CROSTHWAITE FURNACES and SCRIVEN MACHINE TOOLS LTD.

York Street Ironworks, Leeds 9 *Tel.: 32411-2*

32, Victoria Street, London, S.W.1 *Tel.: Abbey 2966*

THE FIRST NAME

Ransomes

IN TRUCKS

RANSOMES SIMS & JEFFERIES LTD.

IPSWICH, ENGLAND

PARTS LISTS
INSTRUCTION MANUALS
ENGINEERING
PUBLICITY LITERATURE

We are specialists in the production of all kinds of engineering instructional literature and publicity matter.

Our technical knowledge is based on the experience gained over many years in producing letterpress printing for engineering organisations.

Up-to-date methods, photographic facilities, artists and layout specialists enable us to produce the finest quality work, whether in the form of printed sheets, diagrammatic reproductions, lists or publicity literature.

May we be of service to you?

E. N. MASON & SONS LTD

Arclight Works, Colchester. Tel: Colchester 5191

LONDON · GLASGOW · MANCHESTER · SHEFFIELD · LEEDS · LIVERPOOL · BIRMINGHAM · BRISTOL

Schieldrop ★ Industrial Burners

SELF PROPORTIONING LOW PRESSURE GAS BURNERS

SELF PROPORTIONING COMBINATION OIL AND GAS BURNERS

MEDIUM PRESSURE OIL ATOMISERS

AIR DIRECTORS FOR MEDIUM & HIGH PRESSURE OIL ATOMISERS

HIGH PRESSURE OIL BURNERS FOR OPEN HEARTH AND SIMILAR FURNACES

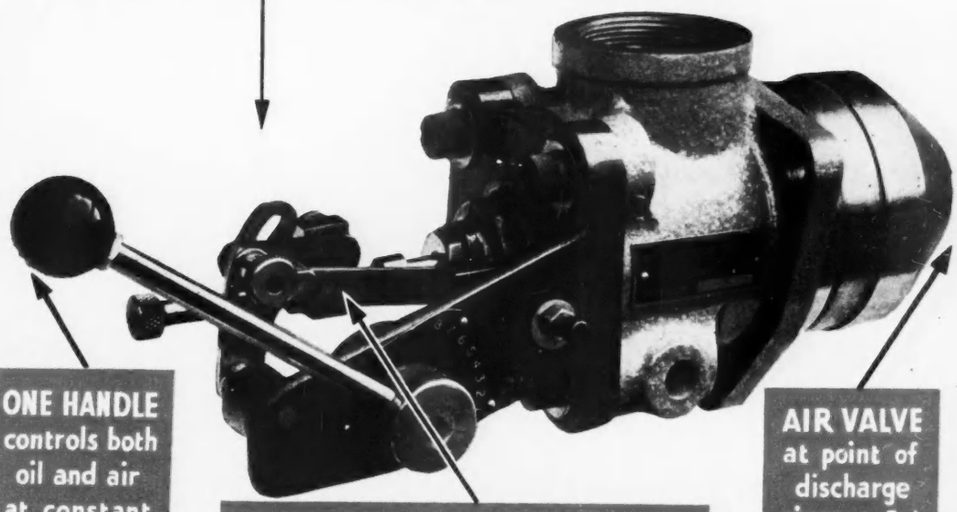
SELF PROPORTIONING MEDIUM PRESSURE OIL BURNERS

VENTURI GAS BURNERS

CONCENTRATED COMBUSTION BURNERS

TEMPERATURE CONTROLLED FORGE FURNACES

The FIRST Self Proportioning OIL BURNER Made in Gt. Britain ★



ONE HANDLE controls both oil and air at constant proportion

NOW made with OIL VALVE STROKE infinitely variable by two adjustments only

AIR VALVE at point of discharge gives a 5:1 turn down ratio

Design and Execution of Complete Installations.

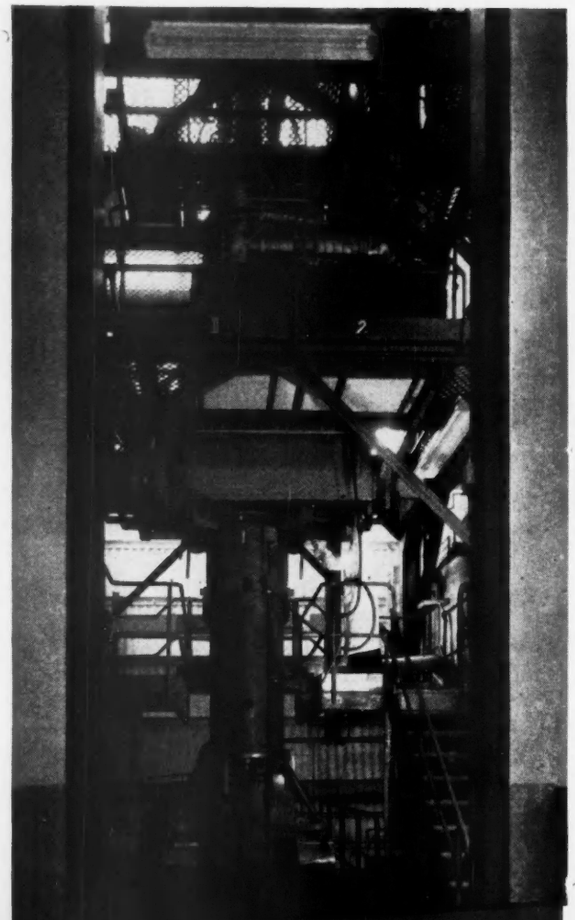
Schieldrop Industrial Burners cover a wide range of types to suit all normal needs. Designs gladly submitted for any type of Burner to special requirements. Schieldrop Burners save tons of fuel, and quickly prove to be a most profitable investment and a highly efficient productive unit. Send for catalogues and full details of operating results.

★ Schieldrop & CO. LTD.

STOTFOLD · BEDS. Tel. 414 (3 lines)

LONDON OFFICE: 2, 3 & 5 STUDIO PLACE, KINNERTON STREET, S.W.1. Tel. SLOANE 0658
SOUTH WALES OFFICE: 11/12 WIND STREET, SWANSEA. Tel. SWANSEA 4951
MANCHESTER OFFICE: 32 DEANSGATE, MANCHESTER. Tel. BLACKFRIARS 3851
BIRMINGHAM OFFICE: 17 WELWYNDALE ROAD, SUTTON COLDFIELD, BIRMINGHAM. Tel. ERDINGTON 2772
SCOTTISH OFFICE: 6 CARRUTH DRIVE, KILMACOLM, RENFREWSHIRE. Tel. KILMACOLM 279

BMJ

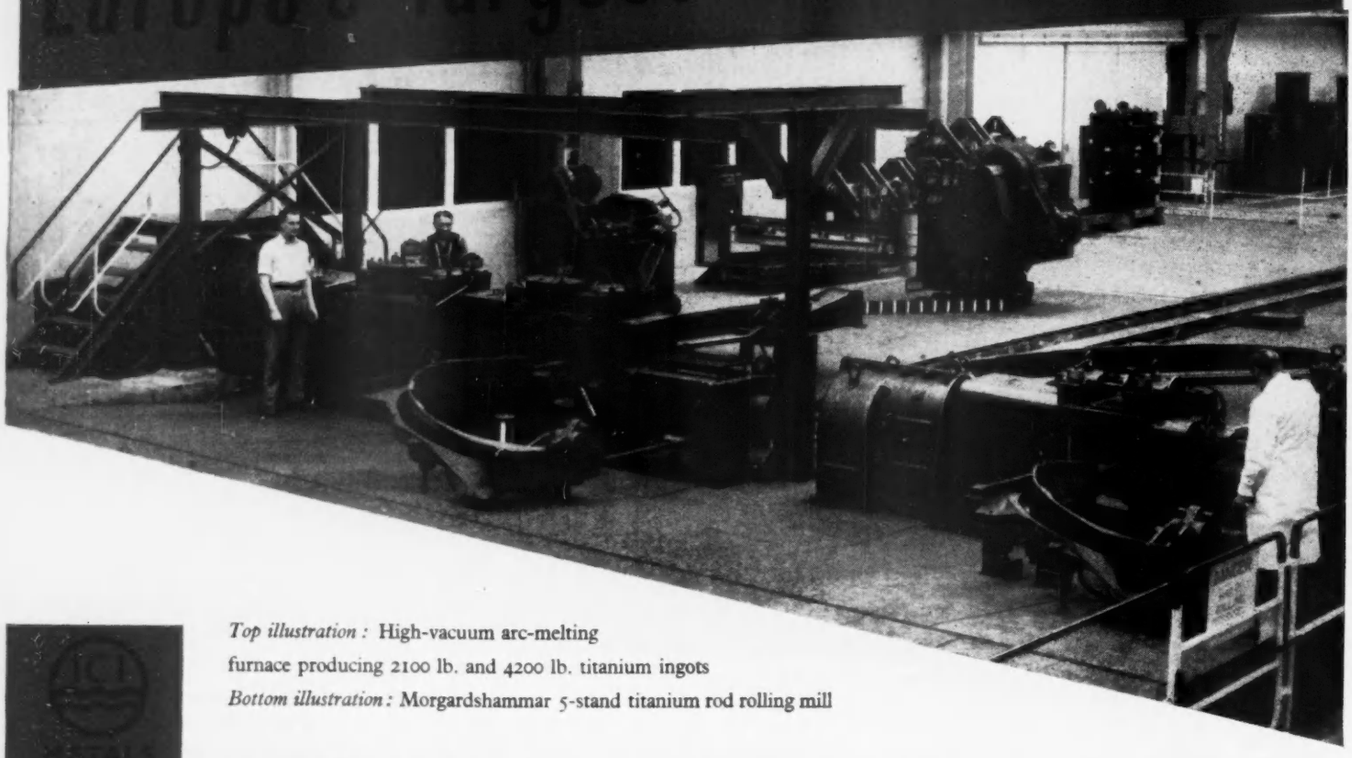


WITH the commissioning of melting furnaces producing 2100 lb. and 4200 lb. ingots and of Britain's first titanium rod and sheet rolling plant, I.C.I. Metals Division has strengthened its position as the largest producer of wrought titanium in Europe.

I.C.I. Titanium and titanium alloys for aircraft and chemical engineering are now available in the widest range of wrought forms—

Forged billet, bar and slab
Rolled rod and bar
Drawn rod and wire
Plate, sheet and strip
Extruded sections and shaped bar
Seamless tube
Copper-cored titanium wire

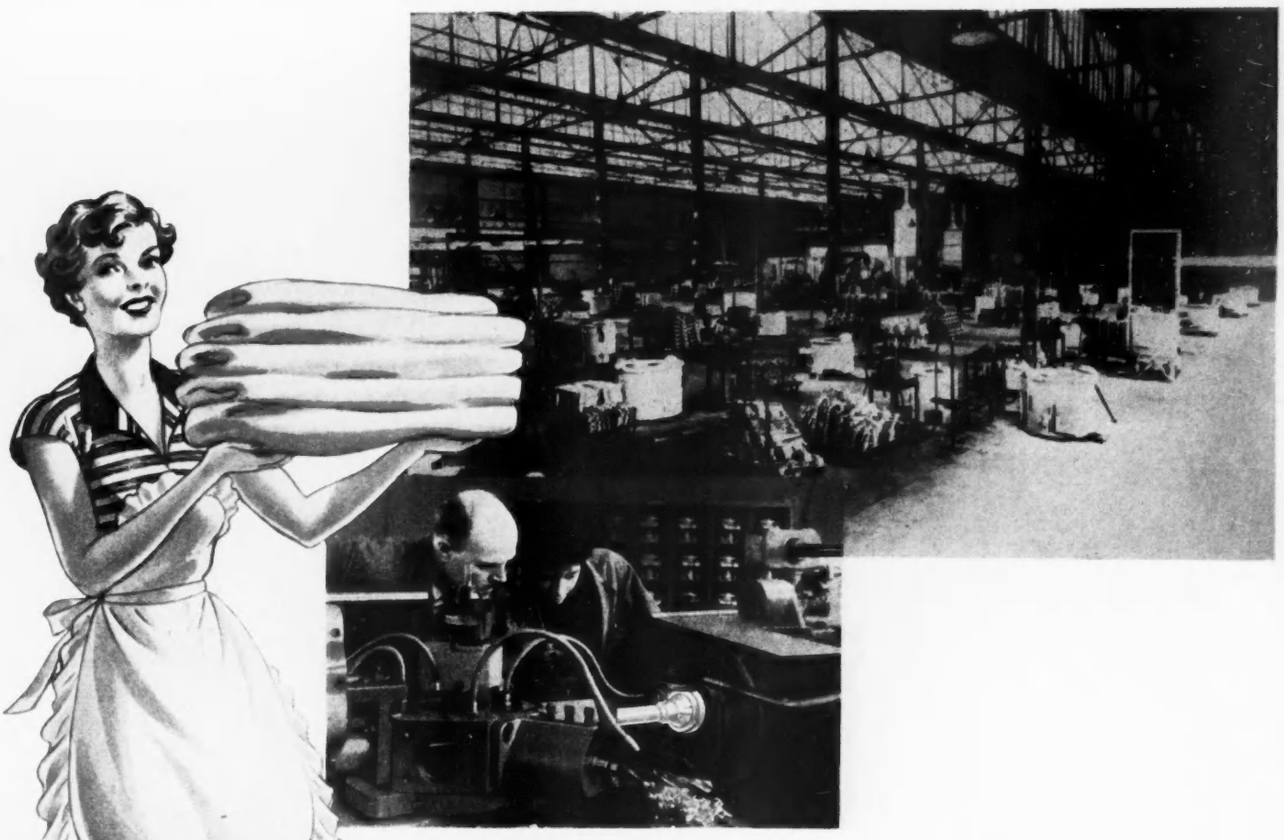
Europe's largest Titanium plant



Top illustration: High-vacuum arc-melting furnace producing 2100 lb. and 4200 lb. titanium ingots
Bottom illustration: Morgardshammar 5-stand titanium rod rolling mill

IMPERIAL CHEMICAL INDUSTRIES LIMITED, LONDON S.W.1

TM26



MAKING LIFE EASIER WITH P·B·M ALUMINIUM CASTINGS

Deep down inside every new Frigidaire Cascade Spin Drier there's a P.B.M. precision machined casting—an essential part in the efficient running (at 2800 r.p.m.) of this modern domestic appliance.

P.B.M. castings are widely used in the products of Britain's leading manufacturers, each one a tribute to P.B.M. craftsmanship and reliability. P.B.M. techniques can also cut your casting costs—let us know your requirements and we will show you how.

PBM

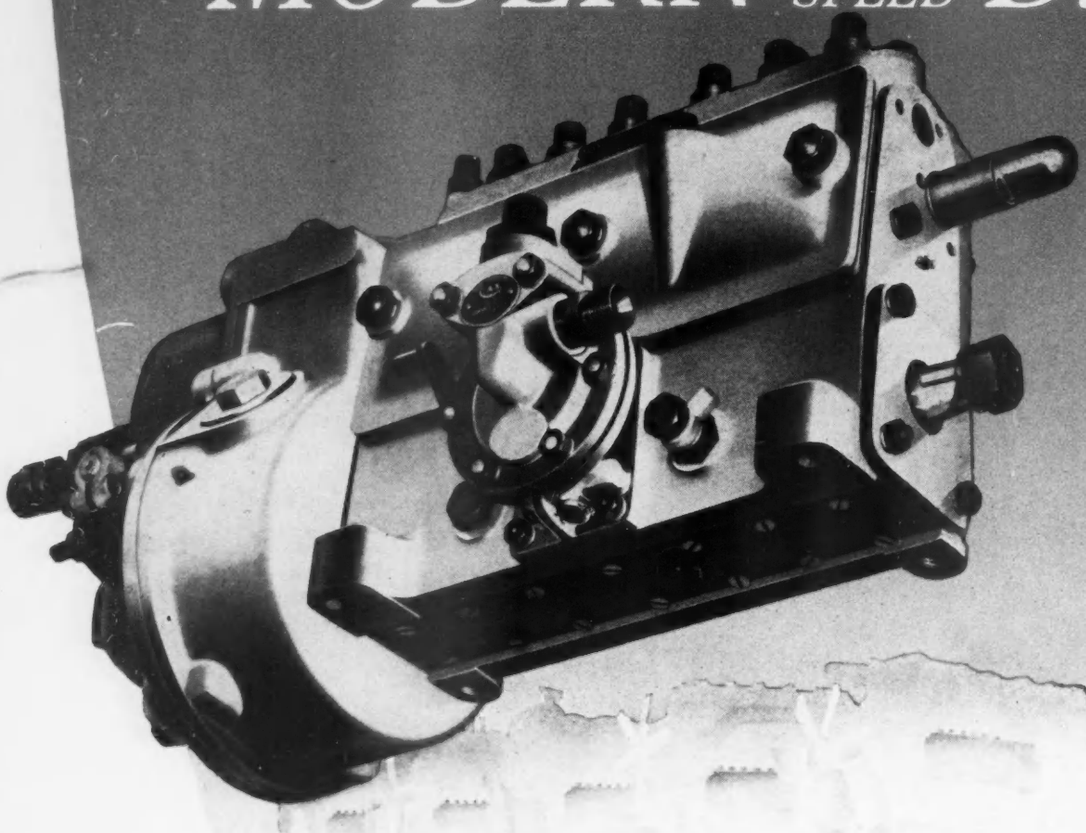
GRAVITY DIE-CASTINGS

★ *MACHINED CASTINGS & ASSEMBLIES*
We have excellent facilities for supplying castings as fully machined components

PERRY BARR METAL COMPANY LTD., GREAT BARR, BIRMINGHAM 22A

TELEPHONE: GREAT BARR 1794-5-6

Designed for the MODERN HIGH SPEED Diesel



The C.A.V. 'N' type fuel injection pump was specifically designed for duty with the higher speed, higher pressure, larger output engines of today.

It was developed in the light of accumulated experience of fuel injection equipment, with unrivalled technical and engineering resources available for the investigation and solution of the many problems involved. Improved features include shorter, stiffer camshaft, through bolt, flat base fixing, increased bearing areas, built-in final filter, improved delivery valve joints, positive phasing adjustments, etc.

C.A.V.

The World's Leading Manufacturers of

FUEL INJECTION AND ELECTRICAL EQUIPMENT

C.A.V. LIMITED · ACTON · LONDON · W.3

AP 916

For that new building....

CONTACT ATCOST LIMITED

—Britain's foremost manufacturers and erectors of

PRECAST REINFORCED CONCRETE BUILDINGS

ATCOST-BUILT *factories, warehouses, transport-sheds, workshops, canteens, etc. are of the highest quality, yet competitively priced. They are fire-resistant, easily-extendible and require no painting or maintenance. For free, 24-page illustrated brochure, and details of our comprehensive service, complete and post this coupon now!*

NAME OF FIRM.....

ADDRESS.....

.....

For the attention of..... E

ATCOST LTD., *Industrial Division,*
THE PANTILES, TUNBRIDGE WELLS, KENT
Tunbridge Wells 3411 (5 lines)

275-kV TRANSFORMERS BY BTH

1951

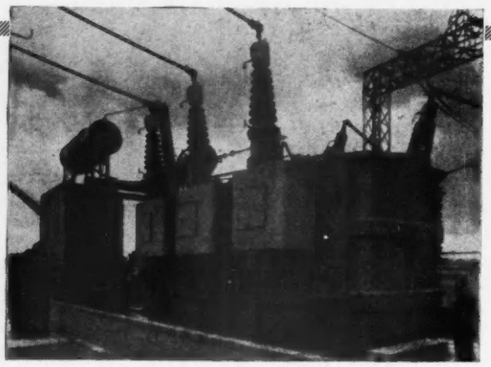
120 MVA UNDER CONSTRUCTION

BTH were first to be awarded a contract for the supply of 120-MVA 275/132-kV transformers for the C.E.A. Super Grid.

1953

120 MVA IN SERVICE

The first 120-MVA unit was commissioned in July 1953. Up to date, ten of these units have been installed or are on order.



120-MVA 275/132-kV transformers at the Staythorpe Sub Station of the C.E.A.

NOW

Another step forward

180-MVA ORDER IN HAND

C.E.A. placed with BTH one of the first two orders for 180-MVA 275/132-kV transformers

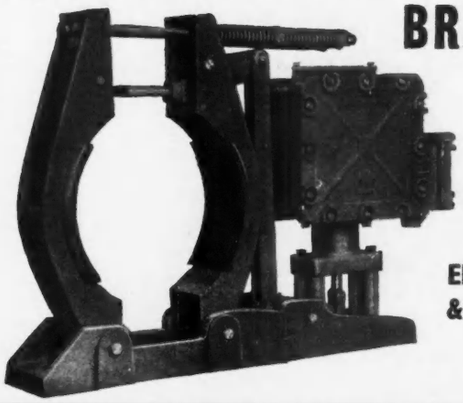
B T-H **BRITISH THOMSON-HOUSTON**

THE BRITISH THOMSON-HOUSTON COMPANY LIMITED · RUGBY · ENGLAND

an A.E.I. Company.

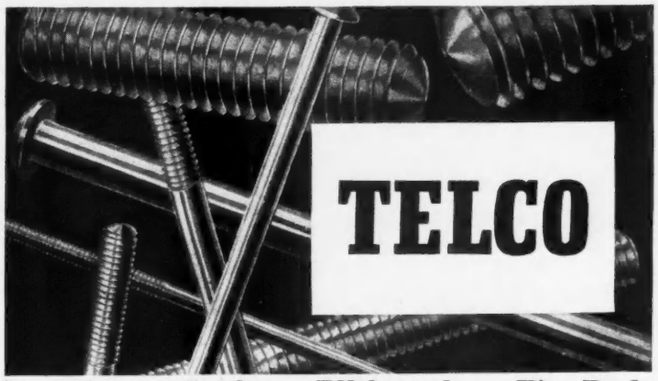
A5298

FLAMEPROOF ELECTRO MECHANICAL BRAKES



A.C. and D.C.

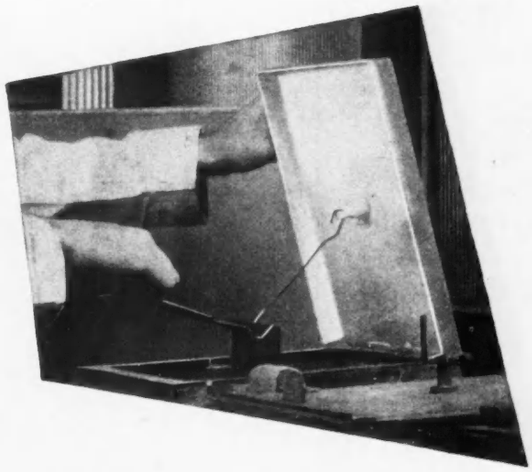
ELLISTON, EVANS & JACKSON, LTD.
LONDON AND BRIDGWATER



Studding · Studs · Allthreads · Tie Rods

TELCO LTD., 3 Newman Street, London, W.1 MUSeum 5701/4

Are these hands helping *you?*



These hands are but a pair among many engaged in the continuous testing and experimental work carried out in P.J. laboratories, where skilled paint technicians tackle the complex problems which confront industrial paint users. Your area P.J. technical representative will bring you the services of this team of experts to advise and assist you with your finishing problems.

You can rely on

PINCHIN JOHNSON

for Paint and Service

PINCHIN, JOHNSON & CO., 4 CARLTON GARDENS, S.W.1

Telephone: TRAfalgar 5600

BELFAST · BIRMINGHAM · BOOTLE · BRIGHTON · BRISTOL · GLASGOW
LEEDS · MANCHESTER · NEWCASTLE-ON-TYNE · SOUTHAMPTON

A DROP OF *Lusol* DISSOLVES THE RUST PROBLEM

MODERN SCIENTIFIC PENETRATING

The Skilled Engineer can best appreciate the scientific value of "LUSOL" in dealing with Rust, Corrosion and Unequal Expansion. "LUSOL" attains a higher degree of penetration, with 100% saturation, in less time than any known Rust Solvent. Its action can be tested and verified by comparing the "rapidity of spread" of one drop of "LUSOL" with that of ordinary solvents.

Used by leading engineers throughout the world. Obtainable in all popular size containers from ¼ pint to 5 gallons.
Insist on "LUSOL"

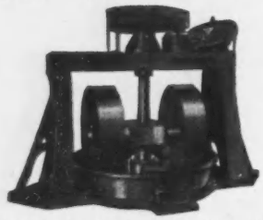
Enquiries to the Manufacturers.

GENUINE *Lusol* REGD. RUST SOLVENT

THE GREAT EASTERN OIL CO. LTD.

372 SCOTLAND STREET, GLASGOW, C.5. Tel: SOUth 2207/8.

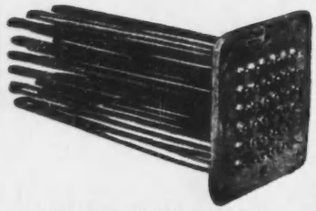
TRADE Smedley MARK
PAN GRINDING MILLS



REVOLVING OR STATIONARY PANS
PERFORATED OR SOLID BOTTOMS
OVER OR UNDER DRIVEN
Smedley Brothers. Ltd.
Belper. Derbyshire.
Telephone: Belper 12

SIRRON
Diesel Engines
Main Propelling
Diesel Engines
in powers up to
1,200 H.P.
THE NEWBURY
DIESEL CO. LTD.
NEWBURY, BERKS

ELTRON
FOR ELEMENTS
for
AIR, OIL or WATER



INFRA-RED OR OVEN HEATING
ELTRON (LONDON) LTD.,
STRATHMORE ROAD, CROYDON
Telephone: Thornton Heath 1861

NORRIS BROS. LTD.
have teams available to undertake
DESIGN, DETAILING
and DEVELOPMENT
in the following fields:-
Aeronautical Engineering
Chemical Plant
Electrical Engineering
Mechanical Engineering
Mechanical Handling
Nuclear Engineering
Plant Layout
Production Tooling
Servo Mechanisms and Automation
Special Machines and Projects
Structure and Reinforced Concrete, etc.
53 VICTORIA STREET S.W.1
– TEL. ABBEY 6132 –

"We seem to be getting more out of her since we had those L & C piston rings fitted, chief."

"What was that, sir?"

"Those L & C piston rings make a great improvement."

"Sorry, sir, I didn't quite get that."

"HAVE YOU GONE DEAF, CHIEF? I SAID THOSE NEW PISTON RINGS HAVE MADE A WORLD OF DIFFERENCE!"

"Oh! I don't know about that, sir, but I must say I'm very pleased with the extra performance we're getting down there with those new L & C piston rings Haven't you noticed the difference, sir?"

LOCKWOOD & CARLISLE LTD

Manufacturers of the well known "Patent Double Action Piston Rings" for steam engines

MAKERS OF THE WORLD'S FINEST DIESEL PISTON RINGS

EAGLE FOUNDRY SHEFFIELD 11 ENGLAND PHONE: 63207 (3 LINES) GRAMS: PISTON, PHONE SHEFFIELD
OA/4300

Waste Heat Recovery Plant

Specialists in the design and construction of Steam-Raising Plant utilising waste gases, in the Gas, Chemical, and Ceramic Industries; also Iron, Steel and Non-Ferrous Metal Industries; Heat Recovery from internal combustion engines and similar prime movers in Land and Marine Installations. A direct method of increasing thermal efficiency and saving fuel.

Consult the Specialist in Waste Heat Recovery.
SPENCER-BONECOURT-CLARKSON LTD. 28 Easton St., London, W.C.1. *Tel: Terminus 7466*

RESISTANCE STRAIN GAUGES
By J. YARNELL, B.Sc., A.Inst.P.
Price 12s. 6d. (Postage 6d.
This book deals with the construction and application of resistance strain gauges and with the most commonly used circuits and apparatus. The strain gauge rosette, which is finding ever wider application, is treated extensively, being introduced by a short exposition of the theory of stress and strain in a surface.
Order your copy through your Bookseller or direct from:—
ELECTRONIC ENGINEERING, 28, Essex Street, Strand, London, W.C.2.

23,000,000 gears by OPPERMAN turn for industry every day

S. E. OPPERMAN LIMITED

BOREHAM WOOD, HERTS.

ELSTREE 2021

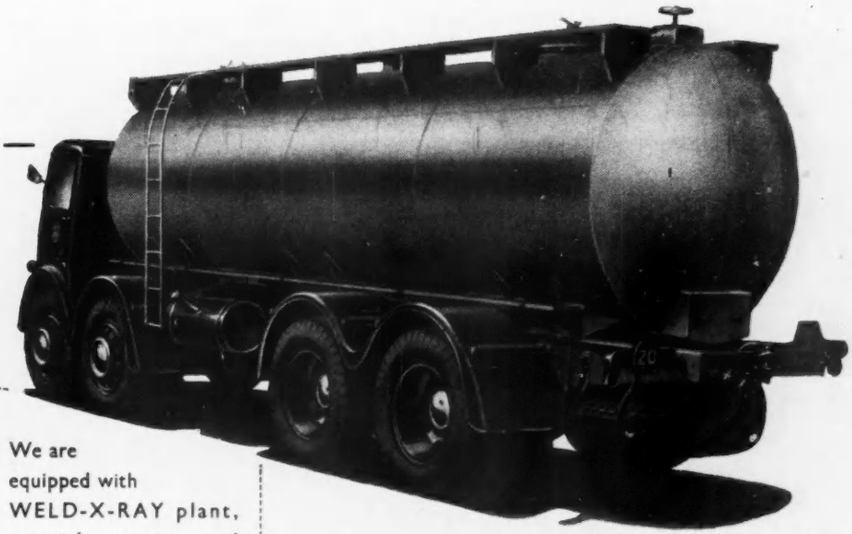
Erwoods

A **'NICKEL'** *might solve your Road Transport Problems*

Butterfields have been building Road Tanks as long as anyone and much longer than most people, and have solved many problems for many prominent operators concerned in the efficient and economical carrying of important liquid loads for the Chemical, Food, Brewing and Petroleum Industries.

Our illustration shows a 3090 gallon single compartment NICKEL Tank for Phenol, mounted on Foden FG6/24 chassis. Built for the I.C.I. Ltd.

Butterfields also fabricate Road Tanks in Stainless Steel, Mild Steel and Aluminium.



We are equipped with WELD-X-RAY plant, materials testing and microscopic examination facilities for any required class of work.

'EPIKOTE'... Butterfields are also equipped for lining Mild Steel Road Transport Tanks with 'EPIKOTE' Resin Based Paints for your special requirements.

'EPIKOTE' is the Trade Mark of the Shell Chemical Co. Ltd.

Butterfield ROAD TANKS

W. P. BUTTERFIELD LTD.
P.O. Box 38 Shipley Yorks.
Tel.: 52244 (8 lines)

Branches:
London: Tel. HOLborn 2455 (4 lines)
Birmingham: Tel. EAS 3871 & 2241
Bristol: Tel. 27905 Liverpool: Tel. CENtral 0829 Manchester: Tel. BLAckfriars 9417
Newcastle-on-Tyne: Tel. 23823 Glasgow: Tel. CENtral 7696 Belfast: N.I. Tel. 57343
Dublin: Tel. 73475 and 79745.

A COMPLETE RANGE OF

'Micronic' OIL FILTERS

Purolator Micronic oil filters provide complete protection for your engine. By removing even the smallest particles of harmful dirt, they drastically reduce the rate of engine wear.

The construction of the 'Micronic' element ensures that the largest possible filtering area is packed into the available space, thus providing longer life.

A relief valve allows the oil to continue flowing if the element is allowed to become completely choked.

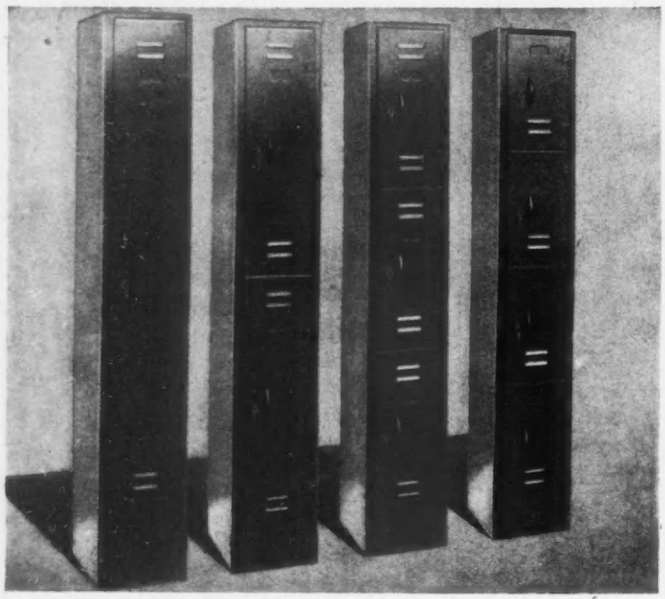
Both external pipe and direct pad mounting types (as illustrated) are available for all sizes of engine.

AUTOMOTIVE PRODUCTS COMPANY LIMITED
LEAMINGTON SPA, WARWICKSHIRE

Regd. Trade Marks: 'PUROLATOR' 'MICRONIC'

PUROLATOR

ABIX STEEL CLOTHES LOCKERS



ABIX CLOTHES LOCKERS are of All Steel construction, with separate hat and coat departments. Single units or banks of two, three or four. Stove enamelled Olive Green. With lock and die-cast handles.

STOVE ENAMELLED GREEN FROM STOCK, COLOURS TO ORDER

Please write for illustrated catalogue E/4 to:—

Size of Single Unit
75" high
12" wide
15" deep

SUPPLIED IN EITHER SINGLE, DOUBLE, THREE TIER OR FOUR TIER

ABIX (METAL INDUSTRIES) LTD.
Steel Equipment for Office and Factory
POOL ROAD, EAST MOLESEY, SURREY
Phone: Molesey 4361/3 Grams: Abix, East Molesey
Also manufacturers of: Steel Cycle Stands, Adjustable Steel Shelving and Partitioning

---

BONDING— RUBBER to DIECASTINGS

Not new or complicated but a practical process, needing care and proper facilities, with which we are experienced and do well.

Pre-bonding treatment and handling castings is particular. We have the essential plant and this work is under Laboratory control.

High rubber-moulding pressures are developed. This should be considered in component design. We would be glad to assist.

Knowledge, experience, competent tool design and production confidence results in better parts, commonsense prices.

The HUNTINGDON RUBBER Co., LTD.
SPECIALIST RUBBER MANUFACTURERS,
Phone HUNTINGDON 934 (4 lines)

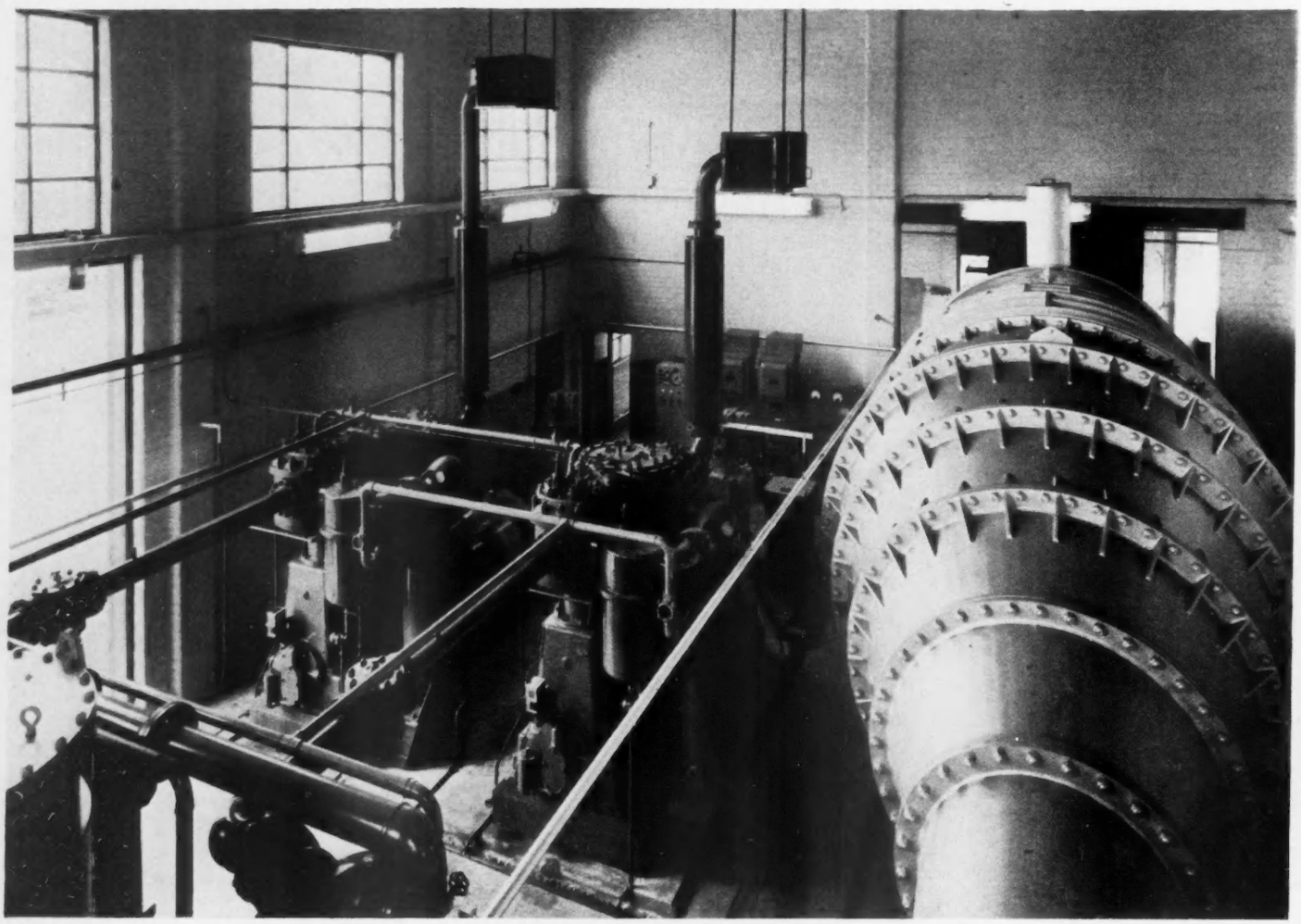
HIGGS MOTORS
CHAIRMAN WALTER F. HIGGS, M.I.E.E. LTD
BIRMINGHAM 6 MADE ENGLAND

VENTILATED MOTORS

STANDARDISED DIMENSIONS
COMPLYING WITH B.S. 2960

Our "Guaranteed for Ever"
is
Your "Gilt Edged Security"

AGENTS AND BRANCHES COVER THE WORLD



Two "BROOMWADE" Type TS2X Stationary Air Compressors each supplying 1000 c.f.m. of free air at 100 p.s.i.g.

Two Organisations with World-wide Reputations

"BROOMWADE" and A. V. ROE & CO. LTD.

In connection with the new Supersonic Wind Tunnel at Woodford Aerodrome, Messrs. A. V. Roe & Co. Ltd. have installed two "BROOMWADE" Type TS2X Stationary Air Compressors. The Tunnel operates on the intermittent blow-down principle, compressed air being stored and then released to give tunnel running times of about 40 secs. and Mach Numbers between 1·6 and 3·5. It is the largest Wind Tunnel in the country capable of such high Mach Numbers, and "BROOMWADE" is proud to be associated with the project.

"BROOMWADE" Stationary Air Compressors are RELIABLE and ECONOMICAL. Simple design, slow speeds and adequate cooling ensure high efficiency, while constant research and development steadily improve performance. Write for full details.

VISIT OUR STAND

PUBLIC WORKS & MUNICIPAL SERVICES EXHIBITION
OLYMPIA
10-15 NOV. 1958

STAND 28
GRAND HALL

"BROOMWADE"

AIR COMPRESSORS & PNEUMATIC TOOLS

Your Best Investment

BROOM & WADE LTD., P.O. BOX No. 7, HIGH WYCOMBE, ENGLAND

Telephone : High Wycombe 1630 (10 lines) *Telegrams : "Broom", High Wycombe. (Telex)*

589 SAS

selected fabrics...

selected resins...

and 21 years' in-built experience

When a bearing is made for a steel rolling mill, it's not just a choice between asbestos and some other fabric, or between one synthetic resin and another, that decides the suitability of the material for the job in hand. There are more than 16 grades of RAILKO: all embody 21 years of research and practical experience. When you want the right material for a specific rolling mill bearing application, for longest life under onerous conditions, call in the RAILKO technician.

RAILKO LTD

participates in the research, technical and productive resources of the Birfield Group, which includes Hardy Spicer, Laycock Engineering, Forgings and Presswork, The Phosphor Bronze Co. Ltd., and other famous companies.

RAILKO
bearings for steel rolling mills

Member of the
Birfield Group

Enquiries to:

BIRFIELD INDUSTRIES LIMITED, Stratford House, London W.1. Phone: GROsvenor 7090

E

Announcing

FENAFLEX

* Fenaflex Couplings are obtainable from all the 19 Fenner branches and Fenner engineers will gladly demonstrate this latest addition to mechanical power transmission equipment.

SEND FOR FULL PARTICULARS. ASK FOR LEAFLET 353/18

H.P. 5744

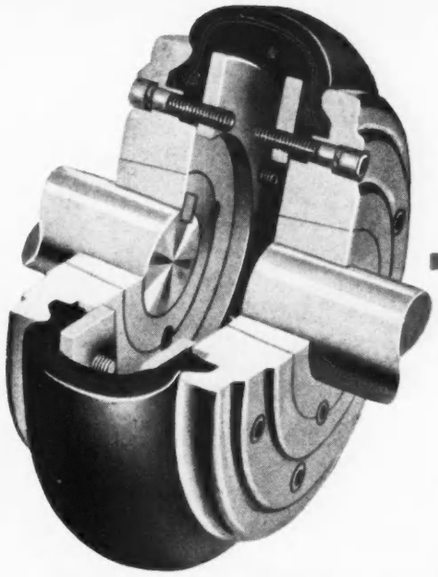
CUSHION COUPLINGS

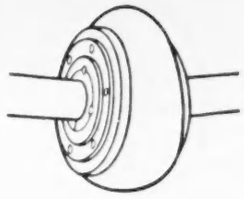
THE RUBBER TYRE COUPLINGS WITH THE 4-WAY FLEX

Fenaflex Cushion Couplings are equal to a universal joint. They automatically correct *all* combinations of misalignment and end-float, cushion shock loads and absorb torsional vibration, yet operate with the dependability of a modern tyre! The Fenaflex Coupling *is* a tyre with synthetic tension members bonded in rubber.

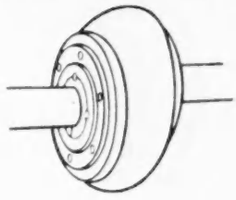
Depending on the size of the coupling and the duration of shaft misplacement, it corrects angular misalignment up to 4°, parallel misalignment up to $\frac{1}{8}$ inch and end-float up to $\frac{5}{16}$ inch. There is no metal-to-metal contact, lubricating is unnecessary and there are no protruding parts.

This coupling occupies the minimum space on the shaft and Fenner standard Taper-Lock bushes make mounting quick and easy. As the flexible member is moulded with a transverse split, it can be replaced without moving the machine or the motor

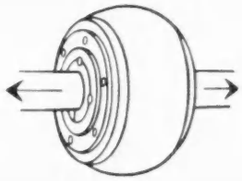




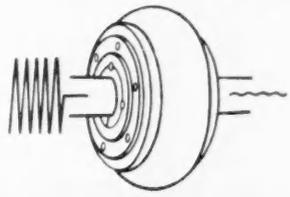
TAKES ANGULAR MISALIGNMENT



TAKES PARALLEL MISALIGNMENT



TAKES END-FLOAT

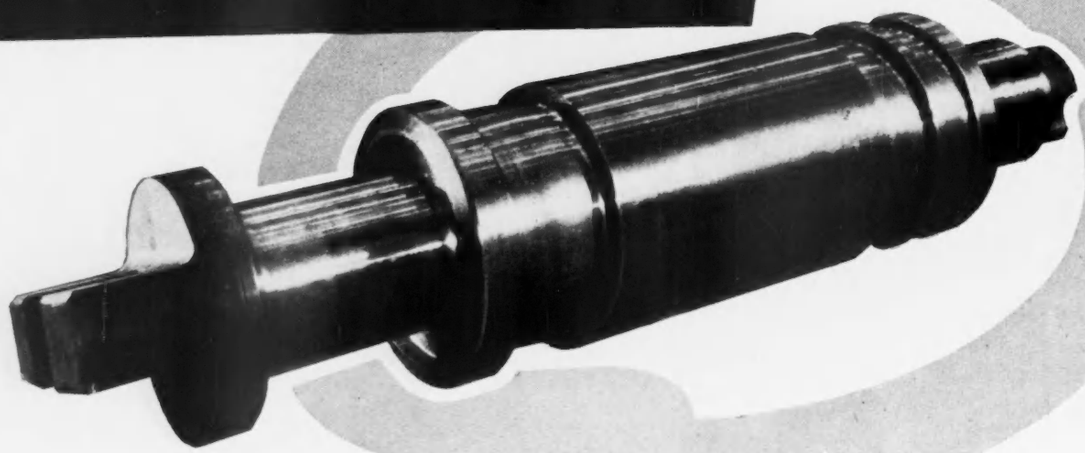


ABSORBS TORSIONAL VIBRATION

J·H·FENNER & CO·LTD·HULL

LARGEST MAKERS OF V-BELT DRIVES IN THE COMMONWEALTH

Forged Steel Slabbing Rolls

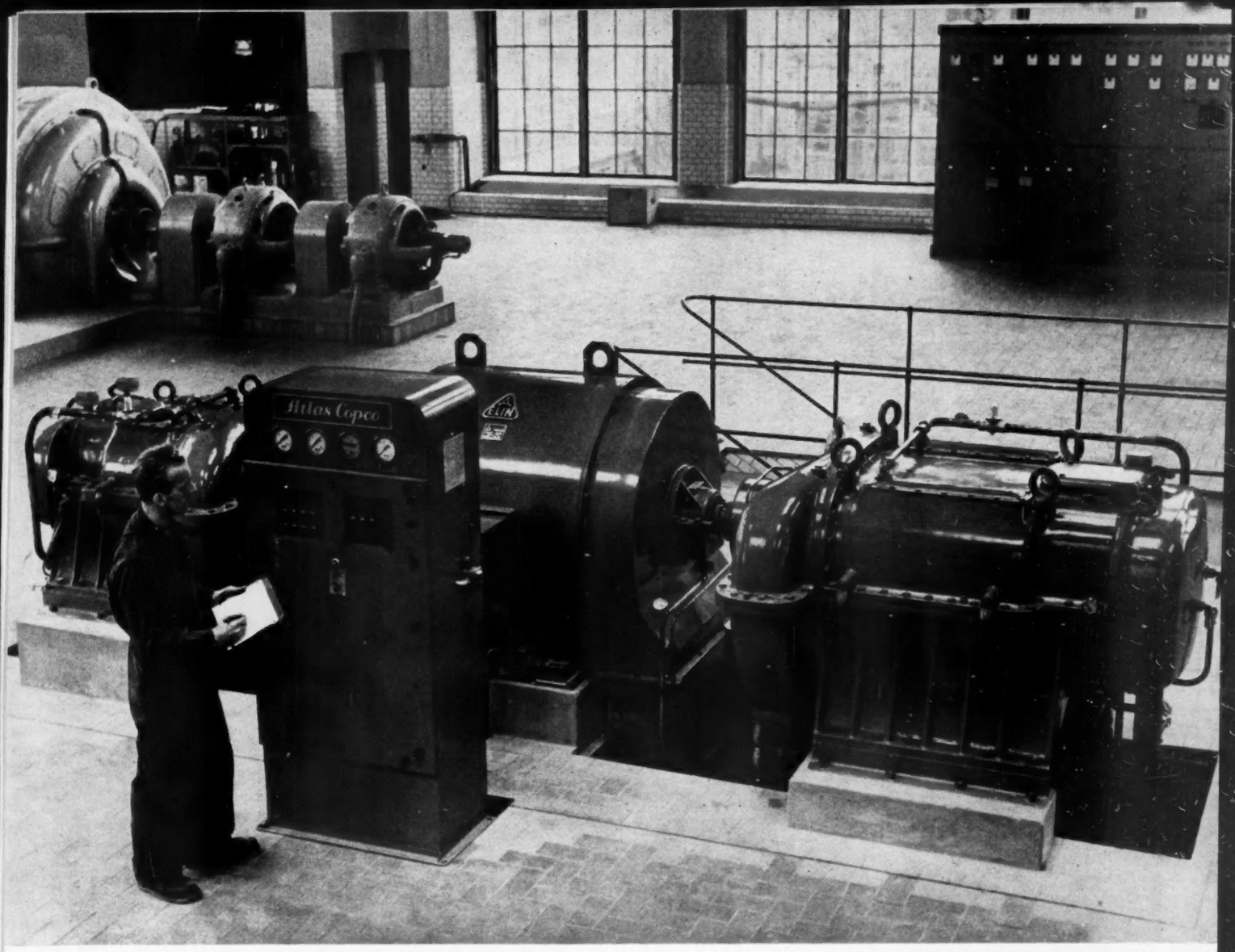


STEEL ROLLS

Cast Steel and Composite Back-up Rolls

The Darlington Forge Ltd

DARLINGTON



An Atlas Copco 'Twin-Air' rotary screw compressor (8,100 cfm) recently installed at the Grängesberg mine, central Sweden.

Tested for two years in Arctic Circle iron mines

THE NEW 'TWIN-AIR'

ROTARY SCREW COMPRESSOR

At Kiruna, in the arctic circle area of Northern Sweden, where the world's largest underground mine is being developed, Atlas Copco rotary screw compressors have been running under full operating conditions for two years.

Simple design, easy maintenance

The Atlas Copco 'Twin-Air' rotary screw compressor is technically simple with few moving parts. As there is no metallic contact between the compression components, need for overhauls are infrequent and little maintenance is necessary.

High efficiency

The high efficiency of the rotary screw compression system means reduced operating costs.

Lower installation costs

The 'Twin-Air' rotary screw compressor occupies less floor space than most other machines of equal capacity. This means marked savings in installation costs. Smaller high speed electric motors also contribute to initial cost saving.

Less sensitive to impure air

Free of any metallic contact between compression components, the rotary screw machine is less sensitive to impure air than any other design.

Oil-free air or gas

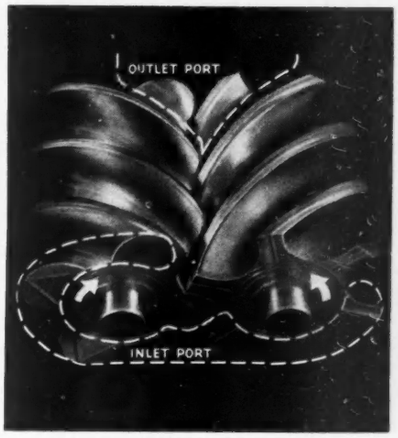
As no lubricant is necessary in the compression chamber, the rotary screw compressor delivers completely oil-free air or gas.

Smooth air flow

The design of the Atlas Copco 'Twin-Air' rotary screw compressor gives a smooth air flow. No 'surging' or 'pumping' characteristics.

Models up to 16,000 c.f.m.

The Atlas Copco standard range of 'Twin-Air' screw compressors includes models up to 16,000 c.f.m. for pressures up to 115 p.s.i. Also available as vacuum pumps.



A pair of rotors with inlet and discharge ports indicated by the dotted lines.

A COMPLETE RANGE OF COMPRESSED AIR EQUIPMENT

Atlas Copco manufactures portable and stationary compressors, rock-drilling equipment, loaders, pneumatic tools and paint-spraying equipment. Sold and serviced by companies or agents in ninety countries throughout the world.

Atlas Copco PUTS COMPRESSED AIR TO WORK FOR THE WORLD

Contact your local company or agent or write to Atlas Copco (Great Britain) Limited, Beresford Avenue, Wembley, Middlesex, or Atlas Copco AB Stockholm 1, Sweden

C.112

One million tons of coal *direct* from Colliery to Power Station

Manchester's Stuart Street Power Station is linked to Bradford Colliery by a single underground conveyor system 2,200 feet long.

The conveyor, supplied by International Combustion, has given years of trouble-free service.

Coal for the Power Station had previously to be transported by rail, road or barge. Now the conveyor belt makes the station independent of outside conditions and gives high capacity, low cost transport.

International Combustion Products Limited supply belt conveyors, gravity bucket conveyors, Beaumont skip hoists and drag scrapers. They are used for handling coal at Power Stations; and in Industry for handling coal and a wide variety of other bulk materials.

IC

INTERNATIONAL COMBUSTION PRODUCTS LIMITED

LONDON OFFICE: NINETEEN WOBURN PLACE, W.C.1. TELEPHONE: TERMINUS 2833

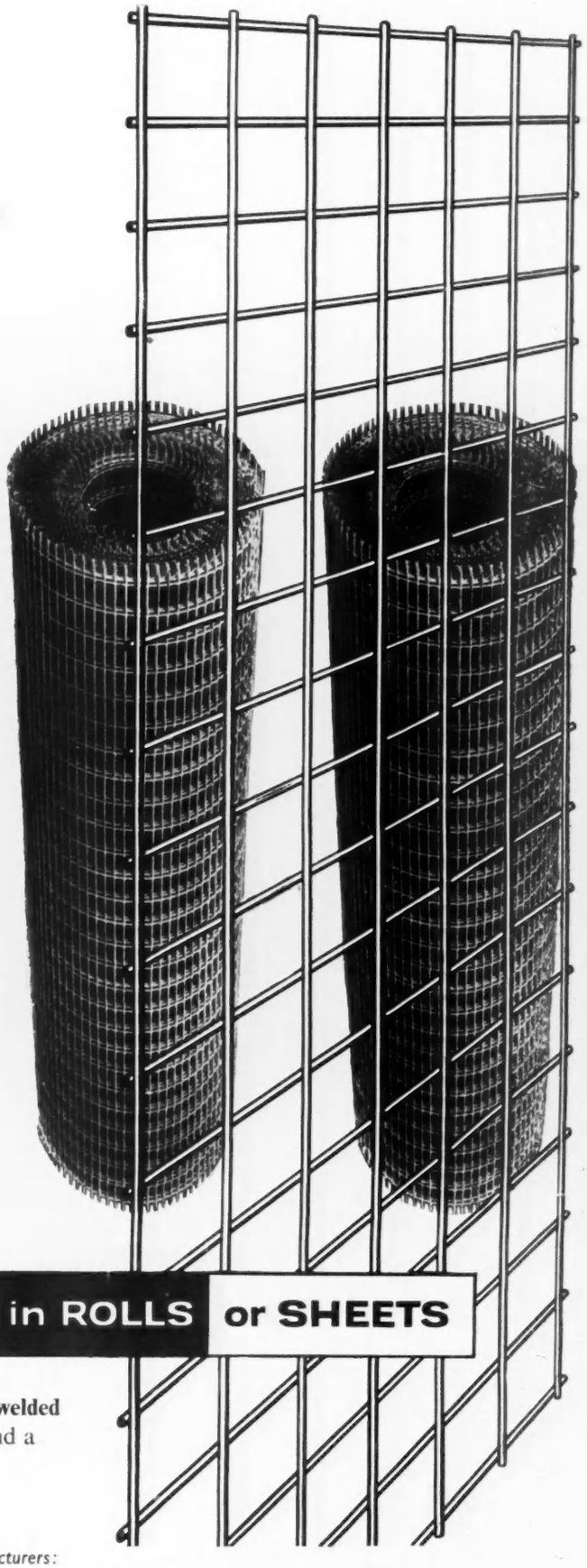
WORKS: DERBY

MEMBER OF ATOMIC POWER CONSTRUCTIONS LIMITED

One of the five British Nuclear Energy Groups

TGA MH18A

Wherever lightness and strength are required–



Weldmesh in ROLLS or SHEETS

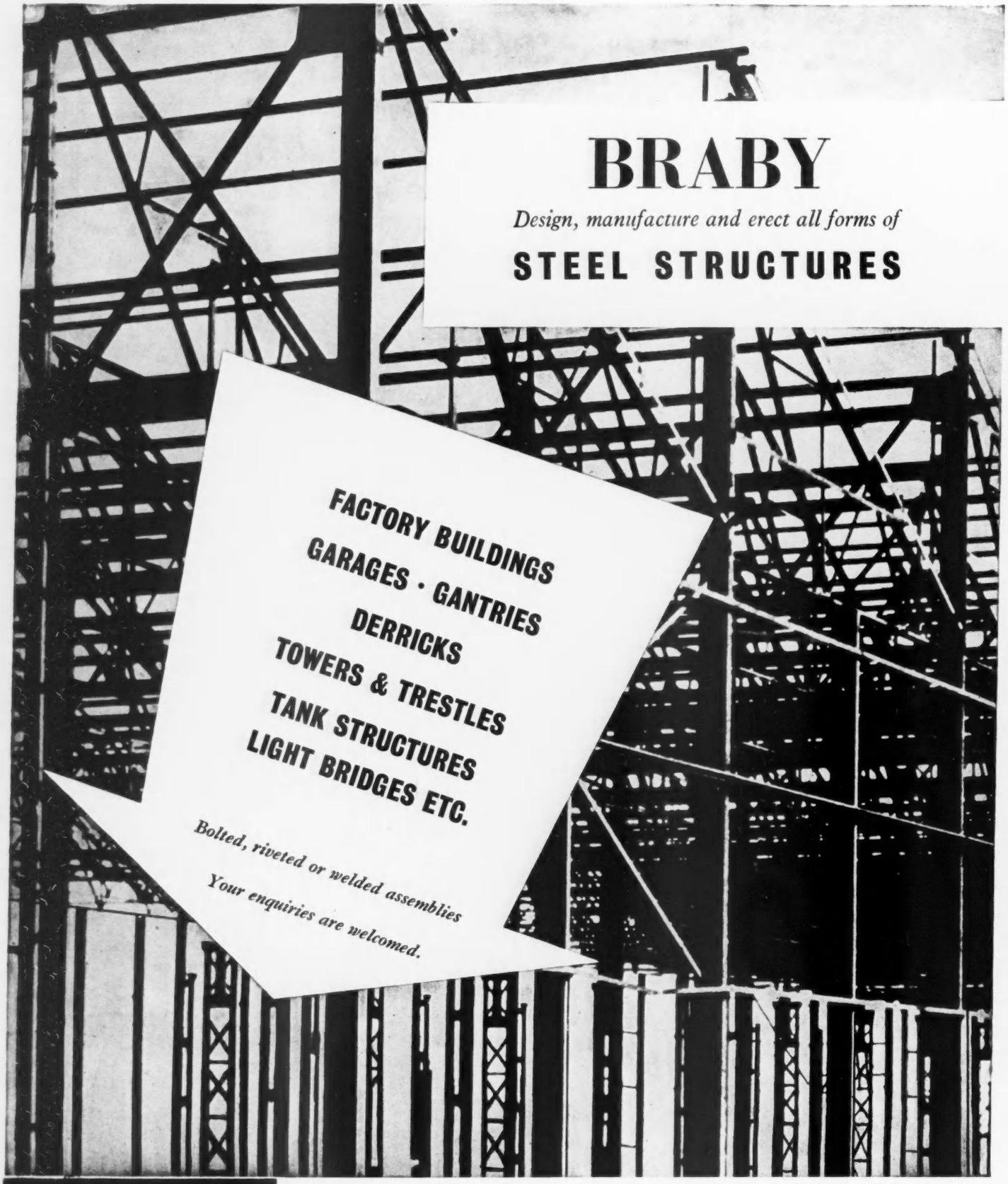
Cut it to the shape you want—it holds together because it's welded together. In the Weldmesh list of standard sizes you will find a mesh size and wire gauge to suit every purpose.
A technical service is available to handle any problems.

Weldmesh is a registered trade name and is supplied direct to users by the sole manufacturers:

THE B.R.C. ENGINEERING CO. LTD., STAFFORD

London, Birmingham, Bristol, Leeds, Leicester, Liverpool, Manchester, Newcastle, Cardiff, Glasgow, Dublin, Belfast, Bulawayo, Calcutta, Johannesburg, Singapore, Vancouver.

Export Sales: 54 Grosvenor Street, London W.1



ONE OF THE WIDE RANGE OF

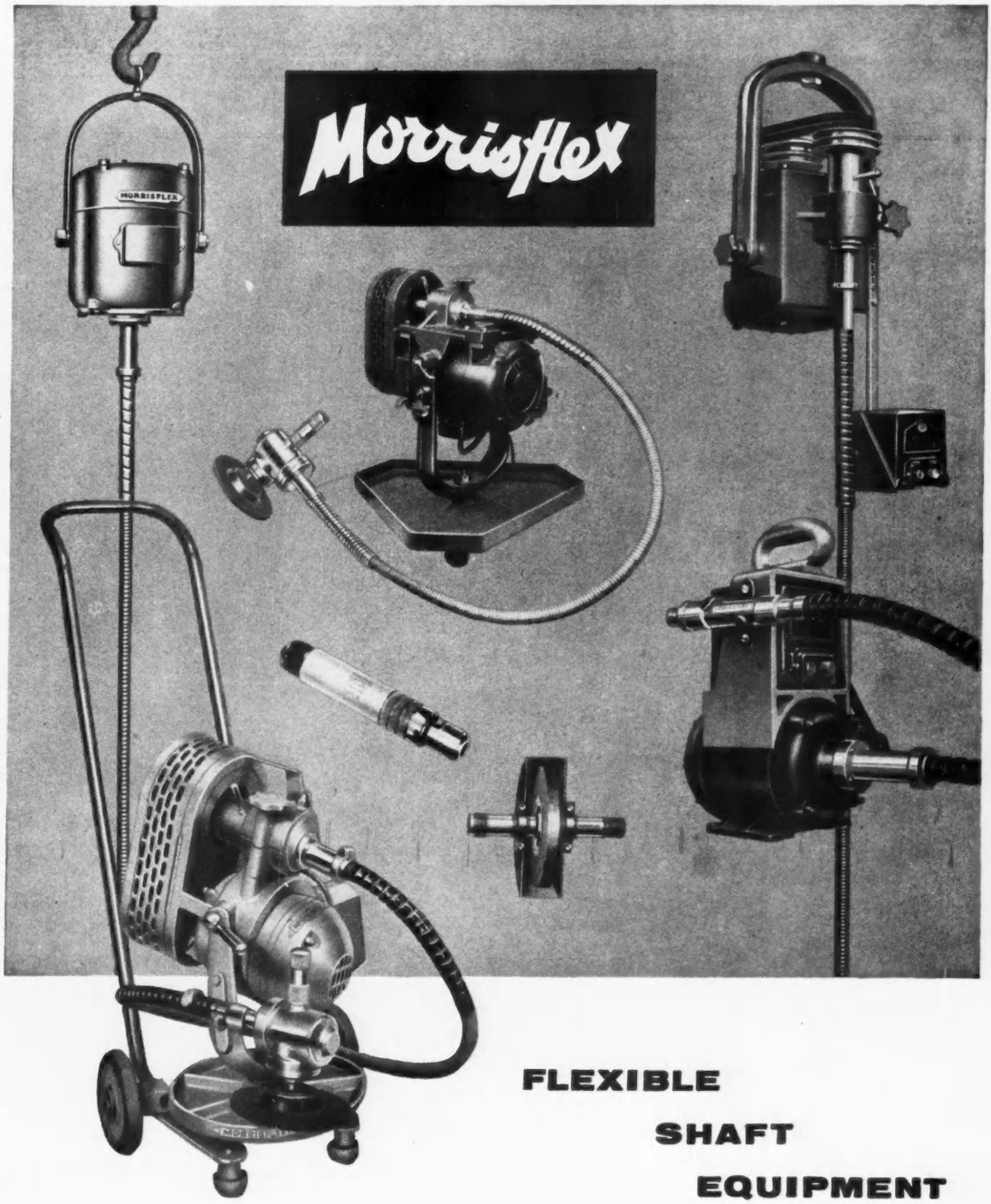
BRABY

PRODUCTS

FREDERICK BRABY & COMPANY LIMITED

Head Office: 352-364 EUSTON ROAD, LONDON, N.W.1. TELEPHONE: EUSton 3456
FACTORIES AT: London Works, Thames Road, Crayford, Kent. TELEPHONE: Bexleyheath 7777
Havelock Works, Aintree, Liverpool, 10. TELEPHONE: Aintree 1721
Eclipse Works, Petershill Road, Glasgow, N. TELEPHONE: Springburn 5151
Ashton Gate Works, Bristol, 3. TELEPHONE: Bristol 64041. And Falkirk
OTHER OFFICES: 110 Cannon Street, London, E.C.4. (Export). TELEPHONE: MANsion House 6034
Queen's Buildings, 10 Royal Avenue, Belfast. TELEPHONE: Belfast 26509
Palace Street, Plymouth. TELEPHONE: 62261

AP285



FLEXIBLE
SHAFT
EQUIPMENT

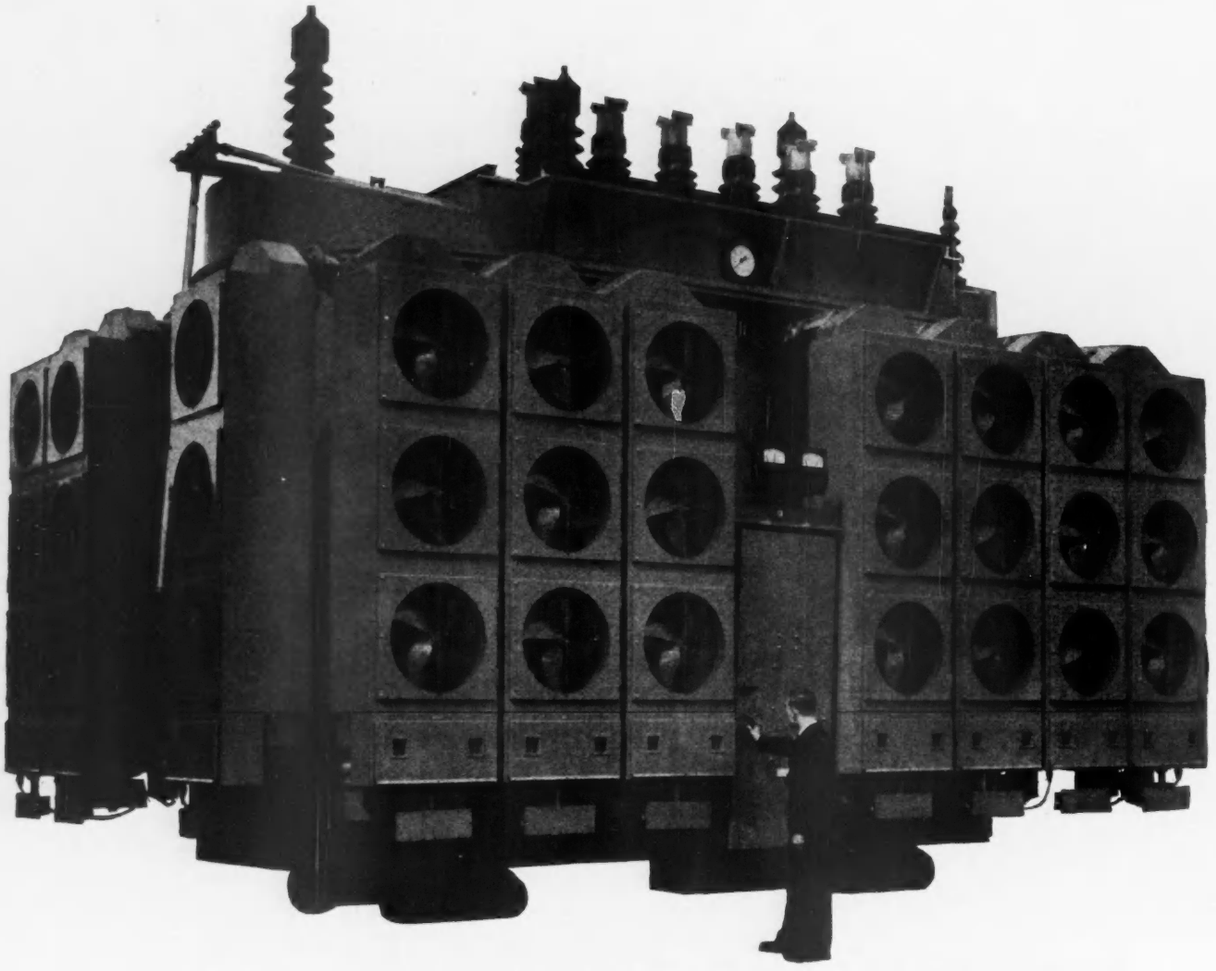
PRODUCT OF THE Morrisflex GROUP OF COMPANIES

HEAD OFFICE

B. O. MORRIS LIMITED, BRITON ROAD, COVENTRY. TEL: 53333

583

the most POWERFUL in the WORLD



345 MVA GENERATOR TRANSFORMER

FOR THE TENNESSEE VALLEY AUTHORITY

fully tested at the Company's Stafford Works prior to shipment

'ENGLISH ELECTRIC'

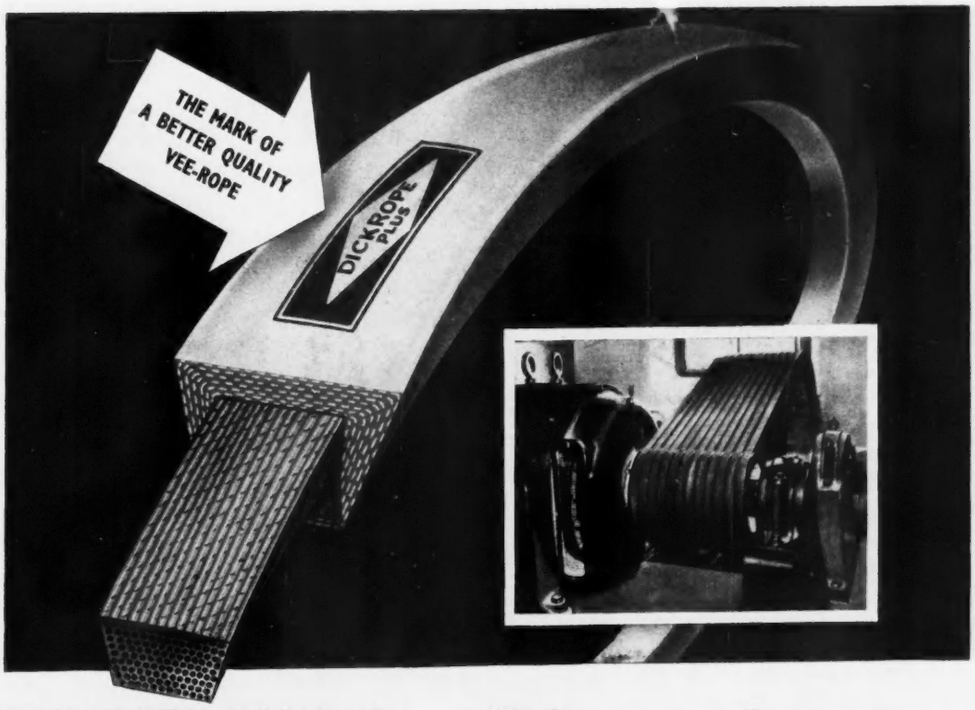
transformers

THE ENGLISH ELECTRIC COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2

Transformer Department, Stafford

WORKS: STAFFORD · PRESTON · RUGBY · BRADFORD · LIVERPOOL · ACCRINGTON

TFS.22 GF



DICKROPE-PLUS for efficiency and economy

HAS HIGH TENSILE STRENGTH FOR MAXIMUM TRANSMISSION

Dickrope-Plus is built rather like a motor tyre. Under the abrasion-resistant outer cover there is an inner core of load-carrying multiple high tensile cords made from specially treated continuous filament yarn. It has just the right amout of 'give' in it, so that, under the repeated strains of high starting torques, pulsalting or shock loads and severe flexing experienced on high-speed drives, Dickrope-Plus retains its shape and its strength. Designed for high-speed machinery and short centre drives, Dickrope-Plus transmits more power than cotton corded vee belts. Available in heat, or oil resistant, and anti-static qualities.

OTHER FAMOUS DICK PRODUCTS INCLUDE

DICK'S ORIGINAL BALATA. The best general purpose belt you can buy.

DIXYLON SUPLEX. The most modern development in power transmission. Specially designed for machine tool power drives. An oil resistant plastic transmission belt with anti-static properties.

DIXIT BELTING. For high-speed drives in hot or humid atmospheres.

DIXEL V-ROPE. Industry's Super Drive. For main engine, generator and countershaft drives. Can be spliced endless with solution and rivets or with our "Quickfix" bolts.

DIXLINK. The link vee-belt that solves problems and presents none. Saves dismantling costs.

RUBERIX. The solid woven rubber belt with the high coefficient of friction.

FOR A COMPLETE POWER TRANSMISSION SERVICE

call in Dick's

R. & J. DICK, Ltd.

POWER TRANSMISSION ENGINEERS SINCE 1885

GREENHEAD WORKS, GLASGOW, S.E.

Telephone: Bridgeton 2344-5-6-7
Grams: Guttapercha, Glasgow.

Branches at: GLASGOW, LONDON, BRISTOL, BIRMINGHAM, MANCHESTER, LEEDS, NEWCASTLE, DUNDEE, BELFAST, DUBLIN, AMSTERDAM and VIENNA. Agencies throughout the world. American factory at Passaic, New Jersey.

ALL BRANCHES TECHNICALLY STAFFED AND FULLY STOCKED TO GIVE IMMEDIATE SERVICE.

WELDED STEEL PLATEWORK
In ¼" to ½" thick Mild Steel

PRESSURE VESSELS
TANKS & CYLINDERS
CHIMNEYS
DRYERS
HOPPERS
CYCLONES
BEDPLATES
ANGLE & FLAT BAR RINGS

C. & M. ENGINEERING CO. LTD.

THAMES Rd., BARKING, ESSEX

TELEPHONE: RIPpleway 3011-2

WOVEN WIRE

F. W. POTTER & SOAR LTD

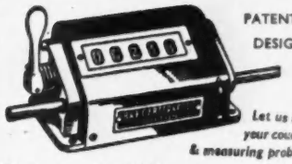
Made in **ALL METALS,**
Our range of Weaving covers all grades from the **FINEST WIRE CLOTH** to the **HEAVIEST SCREENING.**
A.I.D. and **A.R.B.** approved

Please write for our Brochure, containing useful Technical information.

PHIPP STREET LONDON E.C.2

ALBION

Ratchet and Revolution Counters



PATENTED DESIGN

Let us solve your counting & measuring problems

There is an 'ALBION' ratchet or revolution counter for every application. Fit your machines with these efficient counting instruments which will show your output at a glance.

INSTRUMENT DIVISION

B. & F. CARTER & CO. LTD.

BOLTON 3, ENGLAND

'Phone: BOLTON 4344 (3 lines)
'Grams: BRAIDERS BOLTON

PERFORATED METALS FOR ALL PURPOSES

J. & J. POOL LTD
EST. 1843

HAYLE, CORNWALL *Tel. Hayle 3213*

WILLIAM GEIPEL LIMITED

ELECTRIC CABLES
ELECTRIC CONTROL GEAR
STEAM TRAPS

VULCAN WORKS,
156-170 BERMONDSEY ST.,
LONDON, S.E.1.

P. & W. MACLELLAN LTD.

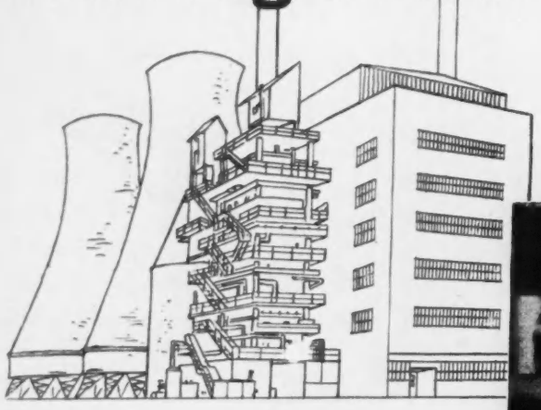
CLUTHA WORKS, GLASGOW

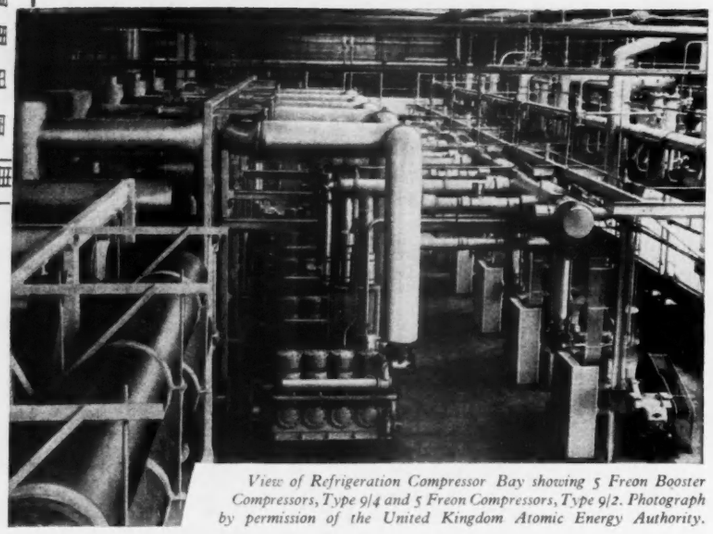
Builders of STEEL BRIDGES, PIT-HEAD GEARS, TANKS, MARINE SLIPWAYS, LOCK GATES, JETTIES, and STRUCTURAL STEELWORK. Manufacturers of STEEL RAILWAY WAGONS, BUFFERS and SLEEPERS. Contractors for RAILWAY PLANT and STORES

Chief Offices:
129, Trongate, Glasgow
Regd. Offices: **Clutha House, 10, Storey's Gate, Westminster, London, S.W.**

Refrigeration in industry

Nuclear Research





View of Refrigeration Compressor Bay showing 5 Freon Booster Compressors, Type 9/4 and 5 Freon Compressors, Type 9/2. Photograph by permission of the United Kingdom Atomic Energy Authority.

For their factory at Capenhurst, the United Kingdom Atomic Energy Authority selected UDEC refrigeration. This extensive installation is but one of the many undertakings with which UDEC refrigeration engineers are currently concerned — ranging from food storage to plastics, brewing to chemical processing, dyestuffs to oil refining, etc.

UDEC

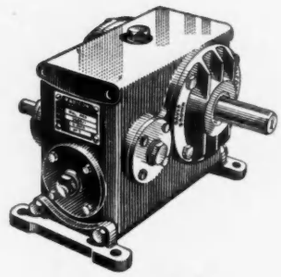
U. D. ENGINEERING CO. LTD.
ABBEY WORKS, CUMBERLAND AVENUE, PARK ROYAL, LONDON, N.W.10
Telephone: ELGar 6581

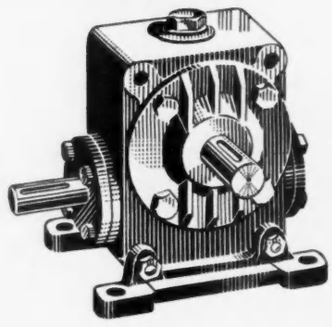
Refrigeration specialists to the industries of the World

UDE4R

Consider my position

With so many mounting positions, and such a wide choice of ratios, the compact and highly efficient Radicon Worm Reducers are in demand for a seemingly endless variety of industrial applications. Built by acknowledged experts in gears and gearing, Radicons are famous for their endurance and reliability with an absolute minimum of maintenance. For useful and comprehensive data, send for Catalogue No. E.387-96.B





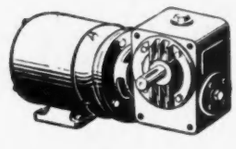
RADICON
WORM REDUCERS 1⅛ 1⅝ 2¼

40 alternative mounting positions

64 ratios 5:1 to 3600:1

Highest value at competitive prices

Also available as motorised units



THE **DAVID BROWN** CORPORATION (SALES) LIMITED

LONDON GEAR DIVISION Stonebridge Park Works Nth Circular Road London NW10 Elgar 6824

Getting the most from the mine

Hudson's have the facilities,

the resources and above all the

experience to supply the

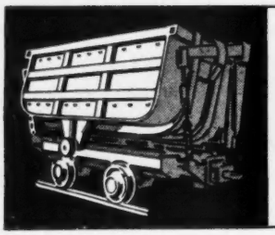
most efficient types of light railway

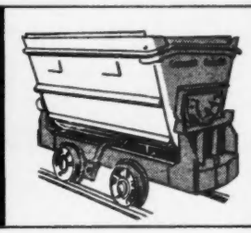
and trailer equipment

for any project

in any part of the world.

6 - Ton, 120 cu. ft. Hudson Side Tip Wagon in use overseas.

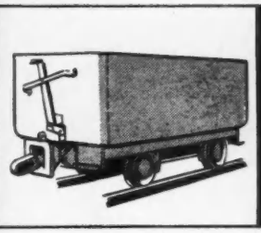




ROBERT HUDSON LIMITED,
RALETRUX HOUSE, MEADOW LANE, LEEDS.
Telephone: Leeds 20004. Telegrams: Raletrux, Leeds.

London Office:
Locomotive House, 30-34, Buckingham Gate, Westminster, S.W.1.

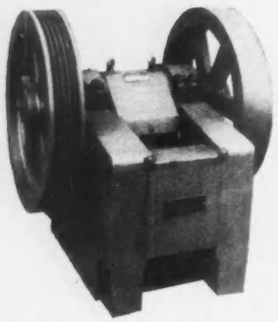
Works at
Leeds, Benoni, Durban & Calcutta.



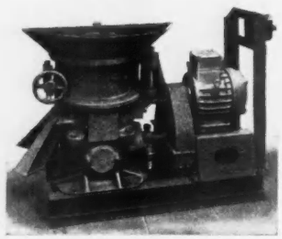
Hudson
LIGHT RAILWAY MATERIALS

STURTEVANT MACHINES

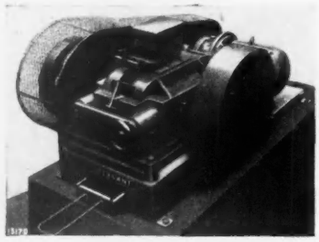
for Coke and Coal Sampling



PRIMARY CRUSHING OF COKE—The Sturtevant 6" × 10" Jaw Crusher is especially suited for reducing coke wet or dry.



PRIMARY CRUSHING OF COAL—The Sturtevant No. 00 Rotary Fine Crusher. It is powered through gearing by electric motor.



SECONDARY REDUCTION The Sturtevant 8"×5" Laboratory Crushing Rolls is for the secondary reduction of coal and coke. It is completely dust-tight.

The Sturtevant Cone Type Sample Divider— gives representative samples of whole batches.

The Sturtevant Laboratory Dryer—Can be supplied where required.

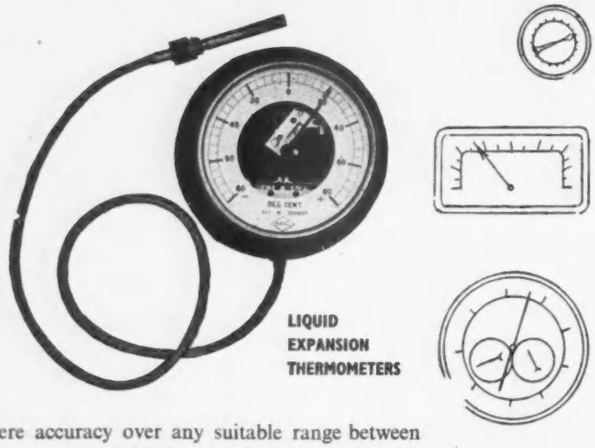
These machines meet the requirements of the British Standard specification for coke and coal sampling and many are used by the National Coal Board, Coke Producers and Iron and Steel Works.

Please address your enquiries to our reference T/101/Z.

STURTEVANT ENGINEERING CO. LTD.
Southern House, Cannon Street, LONDON, E. C. 4.

AUSTRALIA: STURTEVANT ENGINEERING CO. (AUSTRALASIA) LTD. 400 SUSSEX STREET SYDNEY N.S.W.

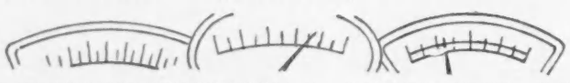
ARIC instruments



LIQUID EXPANSION THERMOMETERS

Where accuracy over any suitable range between a temperature—240°F and 500°F (or centigrade equivalents) is required this fully compensated Thermometer is highly recommended.

Send for illustrated Catalogue of full range.



THE ACCURATE RECORDING INSTRUMENT CO., GARTH ROAD, MORDEN, SURREY
PHONE: DERWENT 2211/2/3

Cheney

THE CLIP WITH A NEVER-RELAXING GRIP

It's the exclusive Cheney design and patented thrust washer and insert that give the Cheney Clip that *extra*, never-relaxing grip. A larger diameter screw ensures deeper, more positive thread engagement to withstand 25% extra torque — and yet the Cheney Clip costs no more than any other type. Always ask for a Cheney Clip and see the difference.

Trade Enquiries to :-
FENTER LTD., 184 ASTON ROAD, BIRMINGHAM 6

VERTICAL CROSS-TUBE BOILERS

also MAKERS of
VERTICAL ECONOMIC and VERTICAL GAS FIRED BOILERS

Early deliveries of most sizes

WALTER W. COLTMAN & CO. (Boilers) LTD.
CENTRAL BOILER WORKS,
LOUGHBOROUGH
Telephone: LOUGHBOROUGH 2351

monk

are proud to announce

the award by

CAMMELL LAIRD & CO LTD

of a contract for

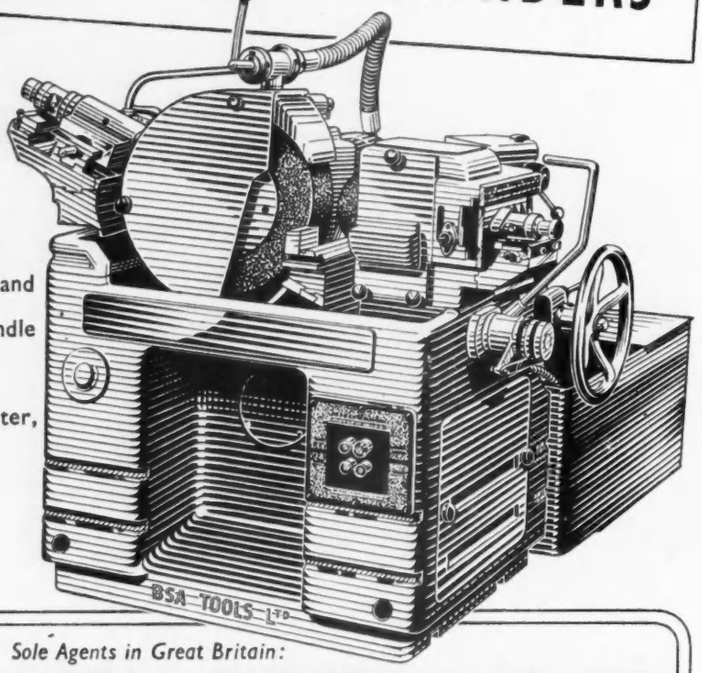
the erection of

NO. 5 DRY DOCK AT BIRKENHEAD

Consulting Engineers: Rendel, Palmer & Tritton

A. MONK & CO LTD. *Warrington and London*
Offices at: Hull, Middlesbrough and Stamford

BSA CENTRELESS GRINDERS

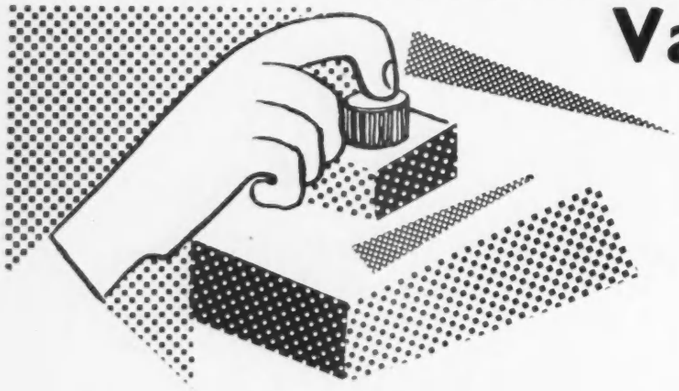


Unequalled for the rapid and efficient grinding of work from $\frac{1}{16}$ in. to $6\frac{1}{2}$ in. diameter, leaving an excellent finish and maintaining a high degree of diametrical and cylindrical accuracy. These machines handle a wide range of work including taper, shouldered, special form and multi-diameter, as well as plain cylindrical.

TRADE MARKS
B·S·A TOOLS GROUP

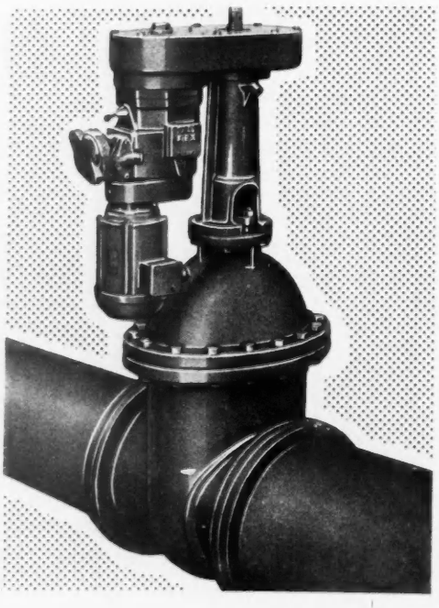
MAKERS
B.S.A. TOOLS LIMITED
BIRMINGHAM . ENGLAND

Sole Agents in Great Britain:
BURTON GRIFFITHS & CO. LTD
KITTS GREEN, BIRMINGHAM 33
Tel: STECHFORD 3071



Valve control at your finger tips

By R.X. ELECTRIC SERVO MOTOR, a **SADI** product specially designed for manual or automatic remote operation.



¾ h.p. servo-motor fitted to valve in water circuit by means of patented universal support; the valve remained in operation throughout erection of unit.

Motorization of a 12 inch valve at 150 p.s.i. for £150

Just a typical example of what can be achieved with one of our units selected from over twenty mass produced actuators ranging from ⅓ to 7 h.p.

ADAPTABILITY TO EXISTING VALVES— IMMEDIATE DELIVERY

Sales and Service Organization in the Commonwealth and throughout the world.

SADI ENGINEERING CO. LTD.
10-14 ANSDELL STREET — KENSINGTON SQUARE — LONDON, W.8
Telephone: WEStern 7653. Cables: SADIUNIT, LONDON.

THE ENGINEER

No. 5361 OCTOBER 24, 1958 VOL. 206

FITNESS FOR PURPOSE

At Earls Court this week there are assembled examples of 306 different passenger cars, British and foreign, large and small, open and closed. So great is the variety that observers have been heard to speculate that any prospective purchaser could find the car of his dreams on offer. In fact, such an unsophisticated idea cannot for long be held once the Show is visited. For scrutiny rapidly detects the absence of vehicles which, in the present state of the art, might well be expected to appear. One is a really all-weather—not off-the-road—car, for those who do not wish to walk in inclement weather, or abandon their vehicle in a flood only inches deep. At one time, such a car might have been got by fitting steel-cord tyres, shielded-filament lamps, and waterproof plugs to a torque-tube-drive vehicle. But the abandonment of opening windscreens on quantity-production cars has opened up a market for a more ambitious project. Similarly appealing to those heavily dependent on motor transport would be a vehicle designed to dispense with maintenance except at very infrequent intervals. Such a vehicle should be within our grasp. We envisage an air-cooled vehicle with no exposed propeller shaft, using, amongst other things, butyl rubber inner tubes and an alkaline battery. It would be more difficult to build a car that was completely driver-tolerant and quite insensitive to abuse, but an approach to it can be seen in the front-wheel-drive two-strokes. The favourable torque curves of such engines should both render them simple to govern and allow them to operate with efficient three-speed automatic transmissions such as were first shown two years ago.

A still more ambitious project would be to devise a vehicle to be controlled " instinctively." Its design would demand a greater understanding of the mental and physical qualities of human beings than exists at present. Motor vehicle makers have shown strangely little interest in this subject. Of course, unless a vehicle is designed from the start to suit certain obvious characteristics of human beings (nearly all of us have two arms, two legs and two eyes !) it cannot hope to survive for long. But there are also certain more subtle characteristics of a vehicle which can be matched against certain more subtle human qualities with advantage. In this respect the first generation of post-war car designs in this country showed much promise. We recall particularly a range of saloons in which the front and rear doors opened the same way and were, reasonably enough, the same size and shape ; and a streamlined 1½-litre saloon which did not demand of the driver the ability to drift if it was to be cornered at its cruising speed. Still with us, but not in its original form, is a high-performance saloon which employed independent rear suspension to reduce the overall size necessary to give comfort to the occupants, and a gearbox changing against the engine torque so that a light high-speed engine could be used without tiring the driver. It might be thought that this latter trend at least would be bound to prosper, but it appears, now, that it posed too many problems for the mechanical engineers. An attempt to make an established " hot shift " gearbox in this country failed, and nothing more than a simple two-speed box is at present available. It is unequal to acting as a splitter between the wider—lower—ratios, so that we see a trend to larger engines simply to obtain adequate low speed performance. An even more radical advance, to provide a machine to initiate as well as execute the ratio changes, has indeed allowed a raising of final drive ratios in some cars, but it has also shown itself a savage problem in control engineering, to the extent that one transmission is inhibited against downward changes when the accelerator is released and another when the throttle is open ! Except for the " Dual Range " transmissions, on which it is possible to choose between maximum range and high-speed cruise regimes, there is virtually no control which " knows " whether the car is being driven hard or not. Engineers do not despair. A solution to this particular problem will, no doubt, be found. Possibly a device which " remembered " how fast the accelerator was being moved could have success in anticipating the next command. But at present a satisfactory solution eludes designers.

In other respects, also, consideration of the characteristics and limitations of the human operator appear to have been allowed too little influence on design. The introduction of hydraulic links between the driver's controls and the actual mechanisms—together with the long-standing success of the Bowden cable—might have been expected to lead to drivers being located by their eyes rather than their toes, with up-and-down movement of the seat and fore-and-aft adjustment of the pedals to accept individuals of different heights. But a code of practice recently published by the S.M.M.T. institutes a merely qualitative measure of adequacy of field of view and hence gives no hint of what field of view will be available to a given driver. Astonishingly enough, power steering systems have been accepted which do nothing to help the driver, since they give no higher gearing, render the feel uninformative, and even, in one of the latest designs, demand a noticeable effort to overcome an irritating resistance in the control mechanism. The main contribution of these complications, so far, appears, in fact, to have been to ease the problems of the tyre and suspension designers rather than to help the driver. It is to be hoped that greater success will attend the application of power to braking, which is highly desirable on several counts. Power braking may be accompanied by the adoption of automatic wheel lock protection, and it is worth recalling that this provision can be justified on vehicles with three or more wheels, although it barely improves stopping distances, because it allows the designer to furnish brakes that would be unmanageable by a human operator if uninhibited. But the most striking denial of the proper order of things, that the machine exists to serve man, rather than man the machine, is the appearance over the last eighteen months

of new or redesigned vehicles in which the occupants, rather than the battery or the gearbox or the engine, have been moved back along the wheelbase to alter the weight distribution !

DIRTY HANDS

In responding to the toast of " Our Guests " at the annual dinner of the Institution of Mechanical Engineers on Thursday night of last week, Marshal of the Royal Air Force, Sir Dermot Boyle, unexpectedly referred to a matter which has proved troublesome to the Institution and irritating to the R.A.F. The Institution accepts for membership men trained by the Royal Navy at Manadon and by the Army at Arborfield but not men trained by the R.A.F. at Henlow. The reason for singling out the Henlow College in this apparently invidious way is that the Institution is not satisfied that cadets going through that College receive satisfactory practical training, whereas it is satisfied about the courses at Manadon and Arborfield and the arrangements which the Navy and the Army make for practical training. Sir Dermot Boyle, criticising the Institution for making the distinction, expressed the opinion that to become an engineer it was not necessary to have the experience of getting " dirty hands," by which presumably he meant that in his view academic and research experience, followed by experience in doing a job in the R.A.F., was sufficient to produce a qualified mechanical engineer.

Now, of course, since the Institution insists upon certain minimum qualifications before it will accept that anyone is a mechanical engineer according to its definition, it cannot possibly make a special exception for Henlow College. Yet it is obviously unfortunate that the training provided by one of the three armed services, but not of the other two, should not accord with the Institution's rulings. It can also be taken for granted that the R.A.F. is itself satisfied that it is training men to be engineers and training them properly. Of course, given time, the disagreement between the Institution and the R.A.F. would automatically be settled. For either men trained at Henlow are turning out to be just as good mechanical engineers as those trained elsewhere or they are not and it should eventually be possible to establish which. But it would save a lot of the strong feeling which led Sir Dermot to refer to the matter in an after-dinner speech if a conclusion could be reached more quickly ; and the fact that the Institution is now seriously studying afresh what practical training ought to be given to budding mechanical engineers may ease the situation. For though we do not think the Institution would ever go so far as to approve of the Henlow courses as we understand them to be at present constituted, it might so alter its requirements that the R.A.F. would find it less difficult to fall in with them.

There is no dispute within the Institution that some practical training is essential for a mechanical engineer. But what is now being challenged is the necessity for the kind of practical training at present specified by the Institution. In particular, it is being asked whether a mechanical engineer really needs to be taught, in an apprentices' school or in the shops, the elements of several differing handicrafts, and whether he needs to spend very much time working alongside men in several different shops. If it really is desirable that he should learn handicraft skill, it is asked whether it might not be better for him to study one craft exhaustively than to gain a dilettante acquaintanceship with several. Instead of spending a month or two in each of several shops, it is suggested that as much and more could be learned about what goes on in those shops from a combination of lectures, of the reading of books, and, perhaps, of some kind of directed study in each shop over a shorter period. It is further suggested that more extensive experience than at present in the progress, costing, jig and tool design, and test departments, would give the budding engineer a better impression of the operations carried on in a works, and of their cost, of the materials used and their qualities, and of the organisation involved in production, than actually working in the shops. It is suggested that this is the kind of experience he ought to gather as soon as possible and that he ought to have it whatever his final job is to be ; though the time spent in each such department and also in drawing-offices, research laboratories, &c., should be modified according to the field in which the young engineer intends to specialise in after life. These are ideas which certainly should not be rejected only because they conflict with the traditions that an engineer is a man of his hands, able to use hammer and chisel, file and scraper, &c., and that he has been " through the shops," like an apprentice learning by doing rather than by deliberate instruction and from books. For, though every engineer worth his salt retains a high admiration for handicraft skill, the production engineer, in conjunction with the designer, should nowadays be continuously using his brains to devise means whereby expensive hand processes or highly-skilled machine processes are not used in his production shops and are eliminated as far as possible even from the toolroom ! The primary job of a chartered mechanical engineer is to use his brains to improve designs and cheapen production and maintenance methods. Whether or not he happens as a youngster to be interested in acquiring a handicraft skill no longer seems to us, therefore, to have very much to do with any judgment as to whether or not he can become a professional engineer. But it may, of course, have some bearing upon the kind of engineering work he may want to do in later life. Modification of the Institution's ideas on practical training along such lines of thought might allow the R.A.F. to agree more readily with it upon the minimum amount of practical training necessary for a mechanical engineer specialising in aeronautics. But it is finally worth remarking that obviously the Institution and not the R.A.F. must be the final arbiter in deciding what are the qualifications of a mechanical engineer. No special exception in favour of the R.A.F. could possibly be made.

AIRCRAFT ENGINEERS AND OTHERS

In his Presidential Address to the Institution of Mechanical Engineers last Friday, Air Marshal Sir R. Owen Jones spoke of " The Mechanical Engineering of Aircraft Mechanisms." He intended to interest his audience, which he could assume to be not well informed about aeronautical engineering, rather than to instruct it and we do not therefore reprint the Address, for it contained little material unfamiliar to aeronautical people. However, early in the Address the President observed " aviation, with which I have been connected as an engineer for the past thirty-five years, is one of the most important vehicles on which new ideas on maintenance are being brought to fruition. It is quite clear why aviation is a vehicle for this work : the aircraft and its components have to operate intermittently and at varying loads ; they have to endure not only extreme stresses, but very rapid changes and alternation of stress ; they have to undergo fantastic changes of temperature, frequently within a matter of minutes or even seconds ; they must stand variations of 'g' which they, and par-

ticularly the instruments, dislike intensely and, finally, they must be designed to be extremely light and yet as safe as human ingenuity can devise. Human life is always at stake and if failure should occur then the designer must do his best to see that the component fails 'safe.' That is a minimum catalogue of requirements, and when the designer has done his utmost then it is up to the maintenance engineer to do his utmost to the same ends. Small wonder then that aviation is the vehicle for today's advanced thought on operation and maintenance. I feel certain that what is being done to-day on aircraft will have its repercussions on other machines to the greater good of all." That is well said. For certainly the aeronautical engineer has learnt much about the design and construction of devices which not only do precisely what they are intended to do but go on doing so at every time of asking! It is reasonable that other kinds of engineers should seek to gain the utmost benefit by learning from this aeronautical experience. But unfortunately there appears to be a belief amongst some engineers that the aircraft is a queer sort of beast and that to understand anything about it, far less apply any techniques learned from its construction, one must renounce the ordinary engineering world and adopt an esoteric culture. What nonsense!

VIRTUES OF A DOUBTING THOMAS

An essential element in the make-up of a scientist, an element which some of those who attempt to explain science to laymen fail to stress, is that he should be a doubter. He should automatically and always doubt whether other people are right in what they say and in the inferences they draw from what they say; and equally he should doubt whether he is himself right in what he says to others. For to be a doubting Thomas is to retain an open mind. Thereby the door to discoveries is kept open; and to be found out in an error becomes no longer wounding because not unexpected. This attitude is one that engineers as well as scientists can profitably adopt. For many an engineering problem which seems simple enough to solve at first sight becomes progressively more complex as the full implications discover themselves through experiment and discussion, and attempts to design and to place a product on the market; and many other problems will only be fully solved—if they are solved at all—through the work of generations of men stumbling from error to error but also thereby towards the truth. Moreover, it is folly to assume that a problem has been completely solved even though it is completely understood technically. For even technical problems must have some human implications. Indeed, since all the work of engineers is done to serve mankind, technical problems are not worth solving unless, however indirectly, they have some human implications. An engineer, as the consequence of lengthy study in theory, by experiment and by practical development, may conceive a design of something which technically seems more advanced and more fit to serve its purpose than any such thing produced before. It does not necessarily follow that laymen, judging the product by different standards, will praise it as highly. Disconcertingly they may show themselves willing to pay as much or more for what seems to engineers a technically inferior article. Nor are they necessarily ignorant, wrong and silly in doing so. It is much more likely that the engineer has failed fully to comprehend the problem, particularly in its human aspect, which he set out to solve. In fact, the only certainties in this life are to be found where men have agreed beforehand upon the conventions and limits that are to be applied, as in the working out of mathematics. Elsewhere nothing is absolutely sure. Oliver Cromwell, in a letter to the General Assembly of the Church of Scotland, presumably irritated by some intransigence, wrote: "I beseech you, in the bowels of Christ, think it possible you may be mistaken." Those were, perhaps, strange words to come from a dictator. Yet they are worth remembering whenever we feel tempted to "lay down the law" on any subject. For the only absolute fool in this world is the man who is absolutely sure he is right!

ST. CLEMENT DANES

Until a few years ago, the address of this journal, as printed on the last page of every issue, was described as being in the "Parish of St. Clement Danes." Although the ecclesiastical location is no longer included in our address, we are happy to record the completion of the restoration of the church of St. Clement Danes which was built by Christopher Wren in 1681. For over a hundred years, we have lived within sight of its noble spire, we have become familiar with the sound of its bells and, in the pre-war years, we delighted to watch those picturesque traditional ceremonies of distributing oranges and lemons on the last day of March and, a little later in the year, the beating of the bounds by clergy, choir and other officials of the church. In company with other parishioners, we lamented the near destruction of the church in 1941 "by the thunderbolts of air warfare." Now, we acclaim the resurgence of St. Clement Danes. Last Sunday, in the presence of Her Majesty the Queen and other members of the Royal Family, the church was reconsecrated as the Church of the Royal Air Force.

The Engineer—100 Years Ago (OCTOBER 22, 1858)

"THE DEMANDS FOR MONEY."

"If it were necessary to adduce evidence of the growing commerce of the world, the immense amount of coined money in circulation, and the quantity of machinery in existence for the purpose of keeping up the supplies of that article might be cited. The mints of England and France are the principal establishments for the conversion of metal into coin—the principal European establishments, that is—and the quantity of gold, silver, and copper which issues from them annually is enormous. The average productions of each during the last three years amounts to nearly a million sterling in value per month; yet the cry is still more, more! In British India, there are three extensive mints, hitherto under the control of the East India Company, but now transferred to that of the new council and the Crown. Yet these are all inadequate for the requirements of Indian trade and commerce. The Bombay Mint is as large as the Mint in London, that of Madras nearly so, whilst the Calcutta money manufactory, already half as large again as the English mint, is in course of being made three times as powerful. It is being supplied with twelve additional coining presses, each capable of striking seventy or eighty pieces per minute, and which will give it a total of twenty-four presses. Messrs. Boulton and Watt have obtained the contract for this work . . . . .

"Even in Siam the demand for money is great. The capital of that country, Bangkok, is built in the midst of the water, on piles, and the people either swim or paddle in canoes up and down the streets to 'do their shopping'; but cash is wanted, nevertheless. The two kings of Siam have therefore ordered a mint to be constructed and sent out forthwith. Mr. Taylor, of Birmingham, is the contractor for this, and by Christmas, probably, two coining presses, with necessary adjuncts, will be shipped for Bangkok."

Jubilee Conference of Structural Engineering

No. II—(*Concluded from page 602, October 17*)

Our review of the fiftieth anniversary conference of the Institution of Structural Engineers, which was held on October 8 to 10, concludes in the columns below. As with Part I last week, the review is not comprehensive, but consists of selected abstracts from one or two of the conference papers ; the title of the paper and its author are given in brackets at the end of each abstract. The heading illustration shows the arch bridge of 805ft span across the Volta River, in Ghana, which is built with high-tensile steel. Topics discussed below include structural applications of glass-fibre-reinforced plastics, and new forms in concrete bridge construction.

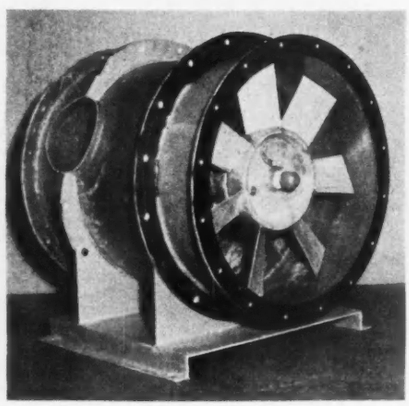
Reinforced Plastics

THE illustration on page 635 shows a large F.R.P. storage tank. (F.R.P.=glass-fibre-reinforced polyester.) It has a net capacity of 20,000 U.S. gallons and is designed to hold a semi-fluid product of a specific gravity about 1·1, under a positive pressure of about 5 lb per square inch above atmosphere. The tank received a proof hydraulic test at a pressure slightly in excess of 13 lb per square inch and proved also to be entirely gastight. The general wall thickness of the tank is about ¼in and the weight approximately 2500 lb. The internal diameter is 12ft and the overall height 29ft 8in. To avoid any local circumferential compressive stresses at the junction of the cylindrical portion to the ends, the top is a full hemisphere and the bottom is a similar hemisphere passing smoothly into a cone with generating lines inclined at 30 deg. to the horizontal. The tank rests on a steel cradle formed from ⅜in by 9in plate rolled to approximate to the slope of the adjacent tank wall. Any irregularities are taken care of by cement grouting. The tank is installed out of doors without any risk whatever of climatic deterioration, and without any need for painting or other protective treatment. A further incidental benefit arises from the fact that F.R.P., if unpigmented, is sufficiently translucent to allow the level of the contents to be clearly seen. Costly and vulnerable sight glasses are completely eliminated and it is a simple matter to calibrate the tank and paint a scale up the side to show the quantity of contents at a glance.

This tank was manufactured and delivered to the customer early in 1957, but it was not until late summer that it was set up and tested. There is every indication that the tank will prove eminently suitable for its purpose. It is also highly competitive in cost with any other type of construction capable of resisting the internal corrosion involved. There is the additional advantage over any type of lined steel tank that it is equally corrosion resistant right through. Thus the need for careful inspection of a lining for cracks and pinholes each time of filling is eliminated.

The size of the fan illustrated may suggest that little structural engineering is involved ; but even at this size the flexibility of the plastics is such that careful consideration must be given to deflection. It is all too easy to build a housing adequately strong by all ordinary standards yet flexible enough to flatten, under a suction of even a few inches water gauge, sufficiently to bring the inlet pipe into contact with the rotor. As these fans are typical of series that ascend in magnitude to 10ft or so across, it will be easy to see that they constitute the first tentative steps in a programme that will provide problems in plenty for the structural engineer. It is for this reason that they have been considered to be a material factor in assessing the future trend of the industry. It is of particular interest to note that the whole of the fan has been constructed of plastics, save only the shaft and bearings.

We illustrate a 21in axial-flow fan. The base to which it is bolted is of welded mild steel, the shaft is stainless steel, and standard flange mounted bearings are used. Otherwise the whole fan is made of glass-fibre-reinforced polyester except for the rivet put in the fan wheel to balance it and the all over surface coat of epoxy resin given to the fan wheel in the light of previous experience in abrasion.



Axial-flow fan of 6000 c.f.m. capacity

The central co-axial tube which holds and protects the bearing mounts is in one piece with the side tube which provides access for the belt drive. This unit is held centrally in the housing by two sets of fins, six just to the rear of the seven-bladed fan wheel and four in line with the belt tube. It is probable that the last mentioned are unnecessary. The accuracy with which assemblies can be performed in F.R.P. is shown by the fact that the clearance between the blade tips and the housing is only $^{7}/_{64}$in. The whole bearing assembly, with shaft and drive sheave, will slide out of its protecting tube for maintenance. It is held in place by nylon bolts.

The fan shown is one of the first pair ever built and was completed at the end of the first week of December, 1957. Although the fans were put in immediate service to replace plastics-coated steel fans that had not proven adequate, it is too early to be able to report on their performance. On test before delivery the most noticeable thing was the absence of vibration and the quietness of operation.

(From "Reinforced Plastics," by W. Butterworth. Acknowledgment is made to the Institution of Structural Engineers for the illustrations referred to in this section.)

Novel Transmission Line Tower

A new form of transmission line tower has been developed and tested by the Civil Engineering Department of the University of Adelaide, South Australia, in conjunction with the Electricity Trust of South Australia. The particular loadings and conditions used were those for a new 275kV line connecting Adelaide with the power stations at Port Augusta, a distance of about 200 miles.

The tower, which is shown diagrammatically, is 70ft high to the cross-arm which carries

the insulator strings. It consists of a three-dimensional triangulated frame composed of eight principal members about 40ft long. These principal members are made of steel tubes either 4½in or 5½in outside diameter. A somewhat smaller tube is used for the single horizontal member halfway up the tower to which all the eight principal members are attached. Four wire-rope tension members running from the cross-arm to

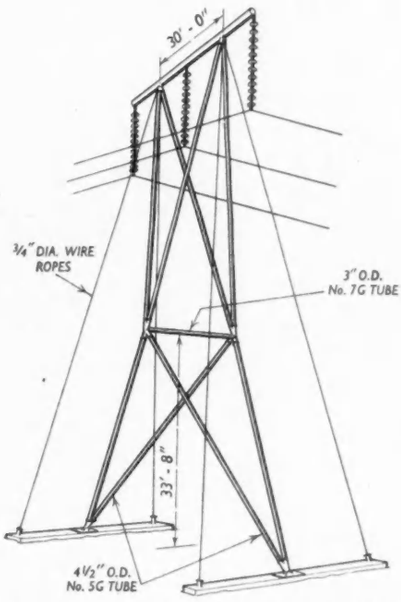


Diagram of space frame and bracing for 275kV transmission line tower 70ft high

ground anchors give stability to the whole structure. These ties, which are ¾in diameter, are pretensioned sufficiently to prevent them going slack under any reasonable loading condition. Pretension of the ties reduces the overall deflection of the tower (under load) and, by the elimination of tension in the principal tubular members, simplifies the site joints. The foundations consist of two concrete beams whose prime requirement is to have enough weight to prevent overturning of the whole structure under transverse loading. The extremities of these foundation beams provide the tie-down points for the pretensioning wire ropes.

The main virtues of the new design are its simplicity, the ease of handling its components and the facility of erecting the tower. All the eight principal members are identical and are fabricated with standard flanged ends which are bolted to the flanges of specially fabricated joint units.

(From "The Development and Testing of a Transmission Line Tower" by Professor F. B. Bull.)

Computers for Structural Analysis

The evolution of new structural forms has led to the introduction of new methods of analysis, of varying degrees of complexity, suitable for the solution of the specific mathematical problems involved. A large number of such analyses is amenable to the application of numerical methods, such as relaxation and iteration, in the derivation of solutions to specific design problems. In carrying out numerical methods the designer has been assisted in the past by either mechanical or electrical desk calculating machines for the numerous arithmetical processes involved. Generally speaking, before setting out on the calculation the designer will draw up a logical scheme, or programme, which minimises the number of actual operations on the desk machine and the ease with which he can do this is a measure of the usefulness of the particular numerical method involved.

With the advent of electronic digital computers in the past few years, the possibility of solving numerical problems of great complexity in relatively short periods of time has introduced a new factor in the assessment of whether any particular mathematical analysis is or is not a design possibility. The time factor is now relatively unimportant because of the great speed of operation of the new machines and the main criterion is the question of whether any particular analysis lends itself to a logical programme applicable to the general rather than the specific problem.

Since there is also much routine numerical calculation involved in all structural problems the electronic computer is also ideally suited to much of the routine office calculation. Most of the problems involved are not mathematically complex but are time consuming in their solution and it is therefore an obvious field in which the use of computers can be of great benefit to the structural engineering profession.

The cost of any electronic computer is such that it is unlikely that the relatively small groups, into which the design side of structural engineering is divided, will be able to acquire such a machine and further, even if one could be acquired, it could probably not be run economically. Therefore it will be necessary to use machines set up by larger organisations and be charged for "machine time"; this system is now widely used.

Pressure storage tank

There are thus two methods of approach to the solution of any problem on a computer. First, the programme for the solution can be produced by the user and all the development work carried out by him; in this case the user would be charged for the machine time involved. Secondly, the problem could be handed over in its entirety to the organisation running the computer for it to do all the necessary programming, operation of the machine, &c. This is virtually a computing service which accepts problems and provides the results. There are already a number of such computing services available.

Obviously both methods of approach have something to offer to the structural engineer but could lead to a certain duplication of work. It would thus seem desirable that what may be called "computer groups" should be formed for the purpose of co-ordinating the activities of the small groups of designers. The purpose of such groups would be to provide information on existing programmes and specifications for such programmes and to provide facilities for discussion and interchange of information on current problems being programmed. Such groups should logically be integral parts of existing Institutions. In America the American Society of Civil Engineers' structural division has recently established a committee on electronic computation to study the application of electronic computers to structural design problems and to correlate the work of the various organisations engaged in this field.

It is clear that an electronic computer is a new tool for structural engineers for use in the solution of both routine and complex problems. The use of this new tool requires very little in the way of exhaustive studies of programming techniques since, both now and to an increasing extent in the future, simplified Autocode processes are or will be available.

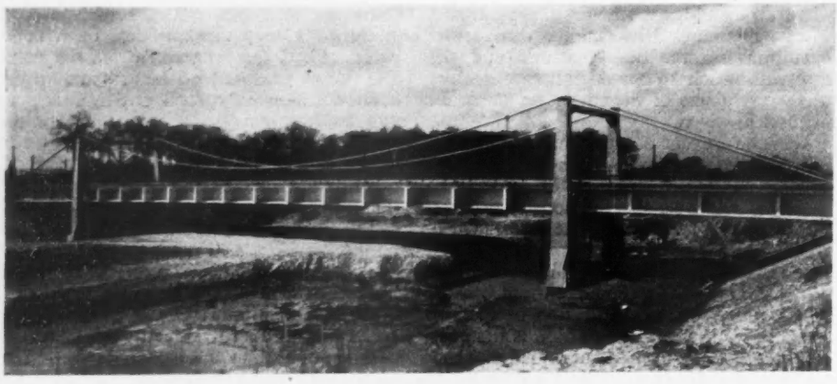
The facility with which computers can deal with vast quantities of arithmetic both quickly and accurately is one which is of great use in the design of complex structural forms. Since the general trend in construction and in innovations in structural form is one of increasing complexity the future application of computers will be on an increasing scale. The designer still retains the integrity of his personal design since a computer can only do what it is instructed to and can never replace the application of engineering judgment.

(From "The Electronic Digital Computer: a New Tool for Structural Engineers," by R. E. Rowe.)

New Forms in Concrete Bridges

In prestressed concrete continuous beams, the designer has the facility of being able to transform a prestressing cable profile in such a way that while the stresses in a beam remain unchanged, the reactions at the supports can be varied. This process, known as linear transformation of a cable profile, has been extended by Professor D. Vandepitte to its logical conclusion to produce a concrete bridge analogous to the steel suspension bridge. This idea has been applied by Professor Vandepitte to a number of bridges; the bridge at Merelbeke across the Ring-canal in Belgium is an example of this form of construction. The bridge is, in Professor Vandepitte's opinion, not a good example of this form of construction since it represents virtually the lower limit to the range of spans for which it is suitable. However, it will serve as an illustration.

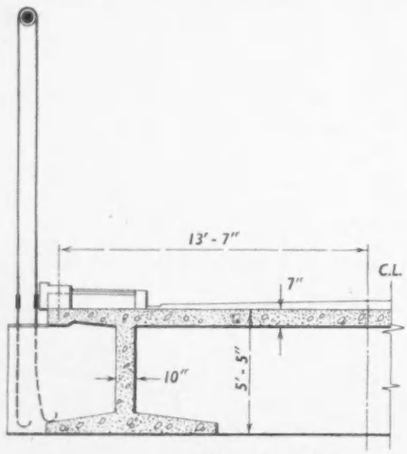
The elevation of the bridge is shown in the illustration. The centre span only is suspended since the side spans are relatively



Merelbeke Bridge

short compared with it. The two main stiffening beams are continuous over the intermediate supports, giving three spans of 59ft, 183ft and 59ft. The action of the cables at the ends of the bridge is counteracted by the large reinforced concrete box abutments which are filled with sand and connected to the end of the bridge by a hinge of the Mesnager type at one end and by eye bars at the other to allow horizontal movement.

The stiffening beams are 5ft 5in deep and the transverse section of the bridge is as shown in the diagram. The suspenders for the cable are bent rods bearing on cable bands and are anchored to the transverse diaphragms of the bridge as also shown in the



Transverse section of Merelbeke Bridge

diagram. The cable itself is composed of 510 galvanised high tensile steel wires of 0·2in diameter which are all parallel. The two main cables are in fact parts of one endless cable which is looped round two end blocks in the bridge deck ; at each block the main cable is split into three separate cables and the wires in each cable are arranged in a steel channel placed round the end block.

Prestressing of the entire structure was effected by pushing up the four columns simultaneously by hydraulic jacks, there being two jacks per column. The rise of the cables governed the amount of prestress applied to the bridge and in this case was 14½in. Since the frame consisting of the columns and their bracing was independent of the actual bridge deck, the elevation of the roadway above the piers was not changed by the prestressing operation.

On completion of the stressing operation, cast steel hinges were placed under the columns and packed into position so that the jacks could be removed. Downward reactions at the intermediate supports are taken directly by the piers, while any upward reactions are transmitted by three tie rods to the foundations.

This form of construction opens new fields in multi-span bridge design, particularly when the spans are of the order of 300ft or more. Professor Vandepitte believes it possible, both economically and technically, to build prestressed concrete bridges of spans up to 1000ft in this way.

The other form of construction which is notable is that put forward by Dr.-Ing. R. Morandi for the Maracaibo bridge in Venezuela. This bridge joins the opposite banks of the Maracaibo Lagoon and has a total length of about 5½ miles. The entire structure is to be in prestressed concrete with ten spans of 490ft and one span of 1300ft and a clearance under the bridge of a minimum of 150ft. It is in the design of the large central span and the two adjacent spans that the new approach is evident. A short description of the design will make this clear.

At the ends of the three-span central section the design incorporates two X-shaped supports ; the outer, upper arms of these supports supply the bearings for the adjacent spans. The other arms serve three functions :

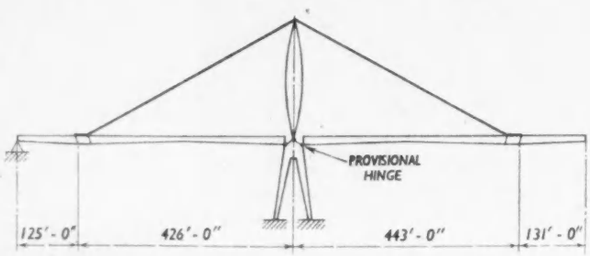
(*a*) To contain the tension ties for the adjacent span.

(*b*) To contain the tension ties for the end span in the central section.

(*c*) To support the end span of the central section.

In this way the ends of the three-span central section are capable of sustaining both the upward and downward reactions caused by the passage of loads across the central section.

The two intermediate supports for the three-span beam are also of special form ; they are shown in the diagram. The end spans are supported on the X-shaped supports and the central piers and also by sloping ties from the top of an extension 210ft high on the intermediate piers. The central span consists of two sections supported by the ties from the towers and a suspended span.



Arrangement at pier of central section of Maracaibo Bridge

The method of construction is for the two sections supported by the ties to be constructed on falsework with hinges at the junction with the intermediate supports. By tensioning the high tensile steel ties to the design value, the beams will be supported and also partially prestressed by the horizontal component of the force in the tie. The simply supported beam will be launched between the two systems in equilibrium at each of the intermediate supports. At this stage the aerial ties will be sheathed in concrete but allowing free movement of the steel. The ties will then be further tensioned to compress the sheath and the cables grouted. Finally, the provisional hinges will be locked.

The purpose of the concrete sheathed cables is to reduce the vertical variations of the elastic supports which depend on the movement in the concrete sheath rather than the steel cables. This ensures that the behaviour of the horizontal elements is completely different from that in a normal suspension bridge.

(From " Developments in the Design and Construction of Concrete Bridges," by P. G. Bowie and R. E. Rowe.)

Sugar Beet Machinery

THE thirteenth annual demonstration of sugar beet harvesting and handling machinery, arranged by the British Sugar Corporation and the National Agricultural Advisory Service, was held last week at Swaffham, Norfolk. In the harvester section of the demonstration, there were twenty-five machines working on a beet crop ; they included six of foreign design and manufacture. In the last ten years or so, a great deal of work has been done by British agricultural engineers on the design of complete beet harvesters, i.e. machines which will top, lift, clean and convey the crop. These annual field demonstrations show the progress that has been made. The majority of the harvesters working last week at Swaffham follow what has now become a generally accepted design principle, namely, machines with the spring-loaded topping knife offset so that the beet are topped one row in advance of lifting. Examples of these machines were described in our issue of June 6 last. The measure of success achieved with these machines can best be gauged by the fact that this year it is expected that about 62 per cent of the 400,000 acres of sugar beet will be mechanically harvested, compared with 0·9 per cent in 1946 (the year of the first machinery demonstration).

There were two other sections of this year's demonstration that were of particular interest ; they were devoted respectively to cleaner-elevators and to handling and transport. At times during the harvesting season, a portion of the crop has to be stacked in the field to await dispatch to a processing factory. The quantity of stones and trash adhering to the roots delivered to the factories is still formidable ! This aspect of completely mechanised beet harvesting is one that is now being given more careful attention.

The machinery demonstration is a thoroughly international occasion. A dinner, on Thursday evening, given at Kings Lynn by the British Sugar Corporation, Ltd., was attended by guests from fourteen overseas countries. In an after-dinner speech, Mr. G. F. N. Battle, managing director of the Corporation, acknowledged that most people went to the demonstration in a critical frame of mind. It was, he said, a " fair attitude " for it was by examining faults rather than perfections that improved machines would be evolved.

Universal Beam Mill at Lackenby

No. II—(*Concluded from page* 608, *October* 17)

The completion of the universal beam and heavy structural mill at the Lackenby works, near Middlesbrough, is the culmination of an extensive programme of development and modernisation which has been carried out by Dorman Long and Co., Ltd. This programme has involved an expenditure of over £60,000,000, *of which the beam mill has required more than* £18,000,000.

IN order to roll standard sections such as angles and channels, the two universal mills can be converted into structural mills, and the breakdown mill is then called in as the primary roughing stand of a three-stand mill. The breakdown mill has rolls of 40in nominal diameter and 96in barrel length. They are driven by universal spindles 21ft 10in long, through a pair of pinions from a main motor of 8000 h.p. with a speed of 65 to 165 r.p.m. The roll neck bearings are similar to those on the edging stands, with thrust collars completely enclosed in the chock. The mill is equipped with electrically driven side guard manipulators, with tilting fingers on both sides of the mill, and a Friemel bloom turner for small blooms on the ingoing side only.

The mill has its own independent roll and spindle balance system, supplied with water at a pressure of 1000 lb per square inch, from a three-throw pump with a capacity of 10 gallons per minute, and an air-loaded accumulator of 42 gallons capacity. From the outgoing side of the breakdown mill a seven-chain transfer can skid the semi-finished bars sideways to the ingoing side of the roughing mill. The conversion of the roughing mill from a beam mill to a structural mill is made by removing the main and edging stands and placing them on the set-up beds. A structural stand, previously set up with rolls and guides, is then lifted into place on the bed vacated by the main universal stand. The ingoing traversing roller table used with the universal mill is next moved out of the way and another table, long enough to cover the gap left by the edger stand, is brought into use. The same kind of conversion is made at the finishing mill.

The two structural stands are similar except that the rolls have a nominal diameter of 40in and a barrel length of 96in. When these stands are in use, the traversing tables act as a manipulator, moving the bar being rolled from one groove to the next as required. When rolling structural sections, the control of the mills is from swinging pulpits. These pulpits, one on each side of each mill, stand on a structure, one end of which is pivoted to the overhead gallery running the full length of the mill, while the other end runs on wheels on a curved track at floor level. The pulpits swing back against the gallery when not in use and out over the roller tables when required.

Hot Sawing and Measuring

Leaving the finishing stand, the rolled bar travelling on the mill run-out roller table can be swept to one side or the other by hydraulically operated sweeps into either of twin roller tables leading to the two hot saws, which are 535ft and 560ft away from the finishing mill. Each saw is of horizontal sliding frame design, traversed by hydraulic pressure, with a stroke of 5ft 10in. The saw blade is 72in diameter, with a peripheral speed of 21,200ft per minute, driven by toothed chain from a motor of 500 h.p.

A particularly interesting part of the sawing installation is the measuring gear, which has been designed to deal with the problem of cutting every bar to the length ordered by the customer, while keeping pace with the mill production. To do this it is necessary to move the measuring head accurately into position in no more time than is taken to cut and move the preceding bar out of the way. On the run-out side of each saw there is a sliding measuring carriage carrying six air-operated hatchet stoppers spaced at 10ft $1\frac{5}{8}$in centres—that is, 10ft nominal plus an allowance for the contraction of the cut hot bar. This carriage can be moved by hydraulic power a distance of up to 10ft so that, by moving the carriage the correct distance, and selecting the correct stopper, any length of bar between 10ft and 70ft can be cut. Carriage movement and stopper selection are both controlled by a set of push buttons in the operator's pulpit, the carriage movement actually taking place while the preceding bar is being cut and moved away. The arrangement is illustrated below.

To move the carriage, oil is supplied to a hydraulic cylinder from a variable delivery pump with a swash plate determining the rate of flow of the oil and the speed of travel of the carriage. The appropriate number of feet and inches up to 9ft 11in having been selected, the operator starts a pilot motor which, working through a differential gear, inclines the swash plate on the pump, so feeding oil to the hydraulic cylinder at the carriage. On the carriage there is a roller chain which, as the carriage moves, turns a sprocket on a shaft connected to the differential, so feeding back the carriage movement. When the pilot motor stops, having taken the number of revolutions appropriate to the selection of feet and inches, the feed back from the carriage which is still moving, returns the swash plate to its neutral position, and the carriage stops in the selected position. The stopper selected for the tens of feet is then dropped, and once it is down the whole selection is locked ; the sawman is then free to make his next selection. While the bar is being cut, the stopper is lifted, freeing the carriage and cancelling the previous selection. The carriage immediately moves to its new position, reaching it in ample time to drop the correct stopper in front of the bar travelling forward to be cut. A further refinement is a second pilot motor to permit variations in the contraction allowance. The centre distance of the stoppers, and the minimum distance of the first stopper from the saw, give a suitable contraction allowance for a bar at the average expected temperature. If, however, a bar being sawn is seen to be at a higher or lower temperature, a rotary switch can be moved to set the contraction pilot motor in motion. This has the effect of increasing or decreasing the travel of the measuring carriage by a known amount, thus giving a greater or less contraction allowance.

Primary Cooling Banks

The arrangement of the cooling banks in the new mill differs materially from that usual in section rolling mills. Instead of having a set of banks, all accepting hot bars on the one side and delivering cold bars from the other, the Lackenby banks are arranged in tandem. The two primary banks take the hot bars straight from the saws, and deliver half-cooled bars to the four final banks where the cooling process is completed. Dorman Long and Co., Ltd., says that the reason for this bank arrangement is because of the difficulties arising from the cutting of customer's lengths at the hot saws. In order to obtain the maximum yield of saleable steel from the rolled bar arriving at the saw, the sawman cannot cut in the succession shown on his order sheet. Generally he chooses two main orders from which to cut, but if neither of these will supply bars of the right length to achieve the shortest possible discard he may select a bar or two from further orders lower down the order sheet.

The hot saw measuring carriage has six air-operated hatchet stoppers ; the carriage can be moved a distance of up to 10ft

One of the two primary cooling banks ; the operator is turning up a beam

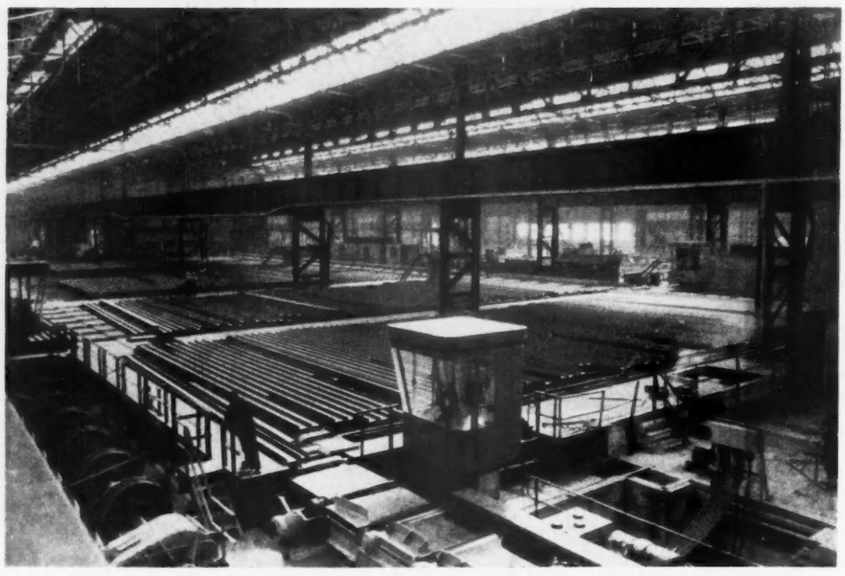
This means that on the primary cooling bank there are, at any one time, bars from two main orders, mixed up with odd bars from orders which will be cut later. Between the primary and the final banks, however, there is an opportunity of collecting all the bars of one order together, thereby reducing the wasteful work of handling single bars by the overhead cranes, and speeding the making up of wagon loads for dispatch.

From the two hot saws, two roller tables serve the two primary cooling banks, illustrated herewith, one table being able to feed both banks, while the other feeds the first bank only. These two banks are each 90ft wide. The first bank is 121ft between centres of roller tables at the hot and cold sides, and the second bank is 127ft. The roller table serving both banks is lineshaft driven through bevel gears, with rollers 4ft 6in long at 7ft 10in centres. The shorter roller table which serves the first bank only is similarly constructed except that the lineshaft is depressed in order to allow the pull-on gear from the other roller table to pass over. The drive from this lineshaft is by spur gearing driving a combined spur and bevel intermediate gear. Motor-operated disappearing stops are fitted at the end and at the centre of each bank, so that two short bars can be placed end to end on each bank. The cooling bank supports are cast iron segments, 2ft long with chevron joints, bolted to steel joists. The rolled bars are swept off the roller table on to the bank by the pull-on gear, comprising a set of eleven carriages running in channel guides and moved to and fro by levers and links from a rocking lineshaft, with a time cycle of five seconds. Each carriage carries a pivoted dog, ambushed on the return stroke, to pull the rolled bar off the roller table, and a second pivoted dog, ducking on the return stroke, to take the bar on to the bank after it has been turned up on to its flange. The carriages for the first bank, where the bar may have to traverse two roller tables, carry a third dog, which not only ambushes on the return stroke, but can be ambushed permanently.

After the first stroke of the pull-on gear, the bar is over the turn-up gear, which, if the bar is a universal beam, can be operated to turn it up on to one of its flanges. This gear consists of a set of L-shaped cradles lying normally in ambush below bank level. They are supported by a system of links and levers from a lineshaft, the upper ends of the links being constrained by rollers running in grooves in the gear housing. When the lineshaft is rocked by a linkage from a crank on the drive gear, the short arm of the cradle rises behind the flange of the bar, which is lying flat. The long arm of the cradle then rises, turning the bar up on to its flange, The cradle drops, to place the upended beam back on the bank, and finally returns to ambush, the whole operation taking four seconds. The second stroke of the pull-on gear having been made, the rolled bar is taken over by the eleven shuffle bars in the bank proper. These are pairs of steel plates, 12in wide, riveted together with spacers, extending most of the length of the bank and carrying between them pivoted dogs at 20½in centres. The shuffle bars are reciprocated with a stroke of 24in and at each stroke all the bars on the bank are moved forward one space. At the cold side of the bank, a set of eleven assembly bars placed alongside the shuffle bars can take charge of any number up to eleven rolled bars, taking them out of the control of the shuffle bars. These assembly bars are, like the shuffle bars, of fabricated plates, with pivoted dogs at 20½in centres. They do not reciprocate but are pulled forward by ropes from drums mounted on a lineshaft. The assembly bars bring the rolled sections, one by one, within the range of the next piece of equipment, namely, the knockdown and pull-off gear, comprising a set of eleven carriages running in channel guides and hauled by ropes from drums on a lineshaft. The function of this gear is to take the bars one by one as they are brought into position by the assembly bars and pull each bar off the bank on to the roller table, at the same time, if the bar is a universal beam, knocking it down from the upright position in which it crosses the bank. The knocking down is done by a special dog in the carriage, additional to the pivoted pull-off dog. This special dog is pivoted and is in ambush at the beginning of the stroke. As the carriage moves forward with the rolled bar, the dog is arranged to lift the back edge of the flange so that the bar falls over forward. The pulling off then continues until the bar is left in the middle of the runout roller table.

Final Cooling Banks

The run-out table from the primary cooling banks is common to both banks, and continues as the run-in table for the four final cooling banks, which are shown in one of our illustrations. On this roller table, every bar cut at both saws passes from the primary to the final banks, and on it all the sorting of the bars into customers' orders takes place. At any one time there are bars on one of the primary banks in their correct sequence, mingled with odd bars which have been cut to improve the discard at the saw and are not in their proper order. As the bars from the primary bank travel along the roller table, those which are in their correct sequence are placed straight on to one or other of the final banks. The odd bars, generally single bars rather than groups, are skidded to a small bank at the other side of the roller table, there to wait until they can be united with the bulk of bars of the order to which they belong. Three of the final cooling banks are 60ft wide, the fourth being 90ft, and all four banks are 125ft 9in between centres of run-in and run-out roller tables. The bank skid rails are steel slabs, supported on edge on joists. From the run-in roller table, the rolled bars are swept on to the bank by the pull-on gear, which is a set of carriages similar to the pull-on gear for the primary banks, except that in this case the



The final cooling banks. The nearest bank is 90ft wide, the other three being 60ft wide

finger is solenoid operated and can push in either direction.

The bars which have been pushed to one side or the other of the roller table are next handled by a set of rope-hauled skid bogies, which bring them within the range of the shuffle bars. These have twelve pivoted dogs, spaced at 8ft centres, with a stroke of 8ft 8in. The shuffle bar operating mechanism has been made powerful enough to move all the bars which can be placed within its range, a load of possibly between 500 and 600 tons. The bars are connected by links to short levers welded into a massive fabricated beam pivoted on a number of bearings and rocked by a hydraulic cylinder at each end. The cylinders are supplied with oil at a pressure of 1400 lb per square inch from a variable delivery pump, and the total force exerted by the shuffle bars is 240 tons. A further set of rope-operated skid bogies can take the bars one by one from the shuffle bars and place them on one of the roller tables leading to the straightening machines.

Straightening Machines

After being cooled, all the material rolled must be straightened, and for this purpose there are four reciprocating presses for the largest universal beams and one roller straightening machine for the smaller universal beams and for other sections. One of the reciprocating straightening machines (illustrated in our last issue), generally known by rolling mill men as gag presses, is placed at the outlet from each of the four final cooling banks, but arrangements have been made by additional skids and roller tables to enable either of a pair of cooling banks to feed either of the two associated presses. Each press is large and heavy enough to straighten the biggest beam rolled in the mill, 36in deep and 16½in wide. One head is adjustable by means of motor-driven screws to enable different sizes of beam to be straightened. The other head has a reciprocating motion of 2in applied from two eccentric shafts driven from a 200 h.p. motor, giving thirty-three strokes per minute. Both heads have one centre anvil and six posts, three on each side of the anvil. All these can be raised by electric power, the controls being arranged so that, at one time, only the anvil on one head and two posts on the other are down. This arrangement enables bends in either direction to be removed without turning the beam over and the variation of post centres accommodates beams of varying modulus of section. As beams must be straightened in both axes, a simple manipulator has been fitted in the roller tables on either side. This is merely two heavy steel pegs, one on each side of the machine, pushed up by compressed air power to raise a beam up on one flange or to throw it down.

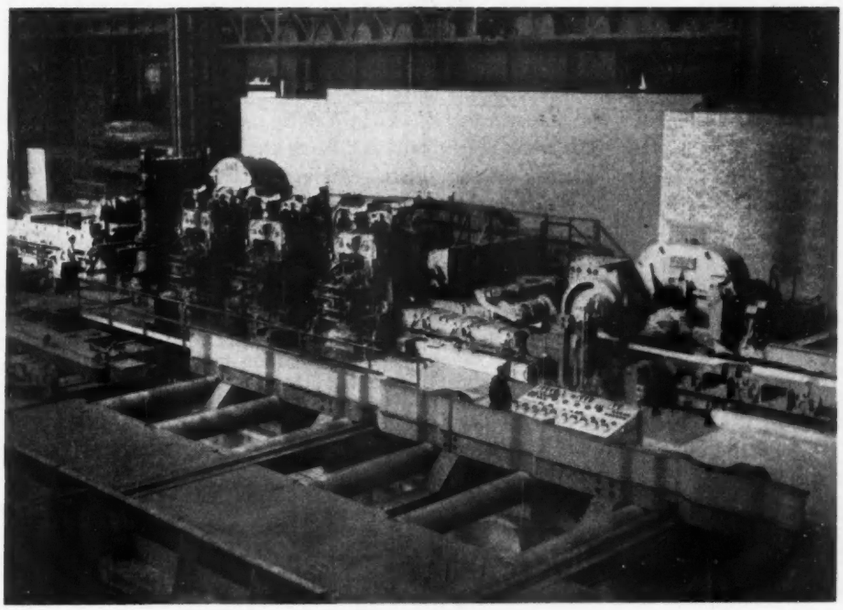
In front of two of the gag presses there are traversing carriages for two roller straightening machines, only one of which has up to now been installed. When the roller machine is out of use, the carriage is traversed to bring four by-pass rollers into line with the gag press. When the roller straightener is in use, the gag press is opened out to allow the straightened material to pass through.

From the straightening machines, the beams or other sections are skidded across to short banks in the piling bay, in which there are two overhead piling cranes. Each of these cranes carries, rigidly suspended from the crab, a beam on which are four vertical rams, actuated by rack and pinion from motor-driven gears, and carrying rectangular bi-polar magnets. The function of these cranes is to pick up the universal beams, singly or in pairs, depending on size, and rest them in neat piles for loading into wagons. The piles are made up on four transfer cars which, when loaded, can be self-propelled into the loading bay. Handling facilities comprise three 15-ton electric overhead cranes serving a double rail track extending the length of the bay.

The Billet Mill

The run-out roller table from the breakdown mill leads direct to the four-stand billet mill, which is placed on the other side of the mill bay from the universal roughing mill. This mill, of one vertical and three horizontal stands, takes blooms 4in square from the breakdown mill, and reduces them to billets of sizes between 1 $\frac{15}{16}$in square and 3$\frac{3}{8}$in square, or to slabs 2in to 2½in thick and up to 12in wide. In the approach table, an air-operated automatic bloom turner turns each oncoming bloom through 45 deg., the air pressure being switched on by the front end of the bloom. Beyond this a swinging frame shear crops the front end of the bloom, and can also be used to sever a billet if a cobble occurs in the mill. Of the four stands, the first is the vertical stand, which can be traversed to bring its pass line into alignment with the various grooves in the following horizontal roll stands. The neck bearings on all the stands are totally enclosed, with liners of phenolic resin bonded fabric, water lubricated. The vertical rolls are driven by a 600 h.p. motor. Stands Nos. 2 and 3 share a motor of 1000 h.p. and a 1000 h.p. motor drives stand No. 4.

The flying shear following the last stand is motor driven, with photocell control of the length cut. It can cut billets up to 4in square, and slabs up to 2½in by 9in or 2in by 12in, in lengths varying from 12ft to 31ft, at the full delivery speed of the mill. Following the flying shear, are the skew roller table, where the cut billets can be assembled side by side, and the entry table to the two cooling beds. Electrically propelled straight edges transfer the billets to the beds. The cooling beds are 30ft wide and 85ft long, and in each of them there are four rope-hauled skid bogies, driven in pairs so that two rows of short billets may be handled on one bed.



Four-stand billet mill; the flying shear cuts the billets at mill delivery speed

Cold Sawing and Beam Slitting

Partly in the piling bay and partly in the loading bay the cold sawing and beam slitting plant is situated. There are two saws, both with vertical slides. The larger saw, with a 60in blade, cuts the largest beams; the smaller 44in saw will handle all the small and medium sizes. All the feed and discharge banks for the two saws, and for the slitting and straightening machines, are fitted with electrically driven skid bogies so that no manual handling is necessary. Measuring of length is automatic. A light carriage on rails is pushed out by the bar which is to be sawn. The sawman has a dial indicating the approximate length and he can see the exact length from a magnified image of the tape on an epidiascope. After cutting, the carriage is returned by a counterweight.

One of the uses to which broad flanged beams can be put is the manufacture of simple plate girders, by slitting the beam into two tees and welding between them a web plate. As part of the cold sawing service, a beam slitting machine has been installed for the purpose of dividing the beam. It is a rotary machine with two circular blades and in the associated roller tables is a centring gear. The slitting machine is followed by a roller straightening machine to take out any sweep which may be produced in the tees by slitting. Large tees, above 12in by 9in, are straightened in one of the gag presses.

The Water System

A comprehensive water system has been installed for the mill, to supply filtered water to all the roll necks, cooling water for the air filtration systems in the motor houses and flushing water for mill scale. The intake of raw water is from the district mains, and it has, therefore, been found essential to recirculate, using town's water for make-up only. The supply to the motor houses is circulated in series with the supply to the bloom heating furnace and has been made an independent enclosed system with its own cooling tower. For the main water supply to the mill, all the filtered water to the roll necks and barrels falls into the scale flumes below and has to be re-filtered. The scale is collected in three scale pits, but from two of

them, at the finishing end and at the breakdown mill, the water is decanted and drained to the blooming mill scale pit, where the three main return pumps send it to the settling ponds on the west side of the mill building. At this point the main water station, settling ponds, filters, pump house and cooling tower, are all grouped together. The two settling ponds, with a total area of 8300 square feet, allow time for most of the fine scale to settle out—heavy scale having already been left in the scale pits—and have provision for skimming oil. Scale flushing water is pumped direct from the ponds back to the mill. Water for filtering is pumped from the ponds to six 35ft diameter tanks, containing a layer of wood wool. The filtered water collected from these tanks is pumped back to the mill at a pressure of 50 lb per square inch, and used for roll neck bearings, roll barrels, and various minor points where cooling is required. As the roll neck bearings must never run without a copious supply of water, two elevated pressure tanks have been fitted in the filtered water system, with sufficient capacity to allow the mill to be cleared and stopped in the event of a complete failure of the filtered water pumps. The quantity of filtered water circulated to the mill is 5000 gallons per minute. The quantity handled by the pumps at the blooming mill scale pit is a maximum of 13,000 gallons per minute, of which 5000 gallons is the filtered water return, 2500 gallons is the continuous scale flush at the blooming mill, and the remainder is from intermittent flushing in the roughing, finishing and breakdown mills.

Stud-Welded Vibrating Wire Strain Gauge

By J. C. CHAPMAN, Ph.D., A.M.I.C.E.

For certain reasons it was decided to make a site investigation of the structural behaviour of the new Mechanical Engineering building at Imperial College, London. Vibrating-wire strain gauges were used, being attached to the structure through welded studs acting as gauge-posts. The design and assembly of the strain gauges is described.

THE structure of the new Mechanical Engineering building at Imperial College is of novel design. The floor beams, which are castellated and have reinforced bottom flanges, are designed to act compositely with the floor slabs, composite action being ensured by means of welded stud shear connectors at the top flanges. Thus the floor slabs make a considerable contribution to the strength of the beams, and in this way a considerable saving in steel was effected. The structural consultant for the building, the first stage of which is now under construction, is Mr. H. Wilson, M.I.C.E., partner in Messrs. Norman and Dawbarn, Consulting Architects and Engineers.

This being the first structure of its kind in Great Britain it was decided to make a site investigation of the structural behaviour of the building. It was desired to record the complete strain history of the steel frame members which were to be instrumented, from their arrival on the site, through erection, concrete encasement, live loading tests, and subsequently during the life of the building. It was therefore necessary that the strain gauges to be used should be stable over a long period, and for this reason it was decided to use vibrating wire gauges.

The vibrating wire (or "acoustic") strain gauge has been used in several different forms, and has a reputation for long term stability and reliability. The gauge makes use of the variation with tension of the natural frequency of vibration of a taut steel wire. The wire is "plucked" by means of an electro-magnet and the same magnet then acts as a pick-up to signal the free vibration of the wire to an oscilloscope. A known variable frequency can then be matched against that of the strain gauge wire, and the change of strain in the structure to which the wire is attached can thus be inferred.

Although the wire is plucked and the frequency is measured by electrical means, the gauge itself is essentially mechanical in its operation, and provided the wire is securely anchored to the structure there is no reason why the frequency should be appreciably affected by causes other than a change of strain in the structure or in the wire. If the structure is steel, and if the wire is insulated from the atmosphere, so that it takes up the same temperature as the structure, then the gauge is self-compensating for temperature, and the gauge indicates changes in stress only.

In principle, therefore, the gauge is simple and reliable. In practice, the difficulty is to attach the taut wire to the structure in such a way that the strain in the structure is faithfully transferred to the wire. There must be no relative movement between the wire anchorages and the structure, even when the strain in the structure fluctuates and perhaps alternates between tension and compression. An anchorage movement of one-thousandth of an inch, on a 6in gauge length, would falsely indicate a stress change of more than two tons per square inch. A gauge has been described* in which the wire is anchored by posts which are screwed to the structure. This gauge has been successfully employed in a major structural investigation undertaken by the Building Research Station. Nevertheless, the B.R.S. design seems to have certain disadvantages :

(1) The screwed-in posts may change their setting slightly as the structure is strained.

(2) The structure must be drilled and tapped. This is a tedious operation and may be structurally undesirable in some cases.

(3) Owing to the difficulty of drilling and tapping holes in the structure, the magnet is fixed internally to the gauge cover, which itself is fixed only by small screws. The distance between the wire and magnet is therefore not precisely determined, and also the cover is liable to be dislodged during construction.

(4) The setting of the wire tension requires considerable experience because the act of clamping the wire changes its tension in a manner which is difficult to predict.

It seemed that these difficulties could be overcome by using welded studs instead of screwed-in posts. The wire could be anchored to rigid studs which would then be monolithic with the structure ; the studs could be correctly oriented without difficulty. The magnet assembly could be mounted from threaded studs below the wire, so that the clearance between wire and magnet could be

* R. J. Mainstone, "Vibrating wire strain gauge for use in long-term tests on structures," *Engineering*, Vol. 176, 1953, page 153.

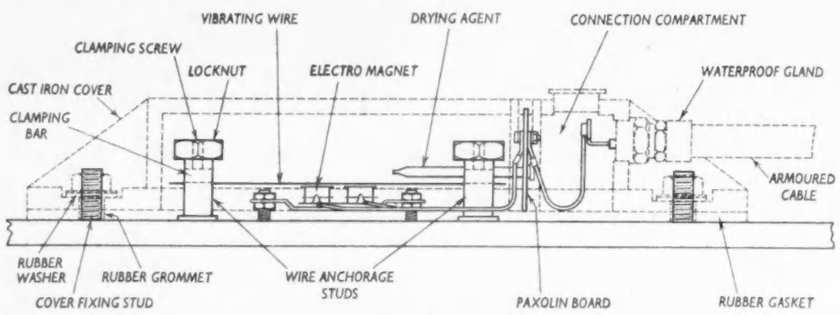


Fig. 1—Strain gauge assembly

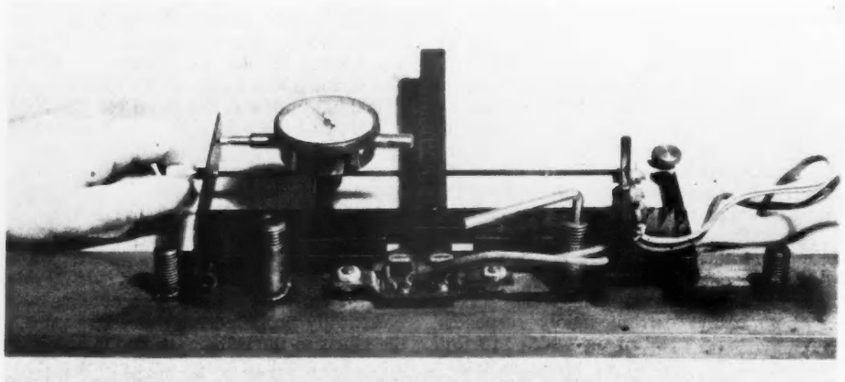


Fig. 2—Wire straining frame

easily and exactly adjusted. Finally, the gauge cover could be robust and fixed by studs of compatible strength. Each array of six studs could be quickly and accurately located by means of a single template. Stud welding is a rapid and simple process which requires no special training or experience ; these qualities seemed especially attractive in the context of the particular project for which the gauges were first required, since the speed of fixing determined whether the proposed programme could be fulfilled or not.

The gauge posts are $\frac{5}{8}$in diameter studs, $1\frac{1}{4}$in long (Fig. 1). A $\frac{1}{8}$in slot is milled to accommodate a $\frac{1}{2}$in by $\frac{1}{8}$in bar to which pressure is applied by an Allen screw concentric with the stud. By this means the wire is clamped between the bar and the bottom of the slot. An external lock nut is provided to prevent spreading of the slot by the Allen screw, whilst at the same time locking the screw and bar. The slotted studs enable a special wire straining device to be used in which the wire is correctly tensioned in a frame and then placed between the slots. The straining frame, seen in Fig. 2, consists

Fig. 3—Template for stud welding

of a bar with a lever at one end to which the wire is clamped by a screw ; the other end of the wire is clamped to the bar. The wire is strained by loading the end of the lever by means of a threaded tie rod, the load in the tie rod being controlled by the deflection of the spring leaf to which it is anchored. The wire can then be clamped, using constant torque spanners, and finally snipped at its ends to release it from the straining frame. Since the pressure is applied concentrically to the clamping bar the wire is uniformly clamped across the whole diameter of the stud, so that the free length of the wire is precisely defined. The uniform clamping of the wire was confirmed by removing a number of wires after clamping and observing that flattening of the wire occurred uniformly across the stud diameter.

The gauge posts are correctly aligned with the welding gun by a tongue within the chuck, which locates in the slot in the post. The gun is aligned with the template (Fig. 3) by locating the tripod studs in holes in the template, the chuck having previously been oriented by inserting the tongue in the slot of a dummy post with surrounding holes. The electro-magnet is mounted by $\frac{1}{4}$in studs and the cover is fixed by $\frac{1}{2}$in studs. By using the same template for locating the six studs the positions of the electro-magnet and the gauge cover are correctly fixed in relation to the wire.

The cast iron cover has a compartment which enables the armoured cable to be connected to the leads from the electro-magnet after the cover has been fixed and sealed. Access to the gauge terminals is obtained by removing a screwed plug ; this enables strain readings to be recorded before the armoured cable is fitted to the gauge, and also allows the cable to be connected. It was therefore possible for the steelwork to be erected with the gauge covers in position, but without attached loops of cable, which may have been damaged during erection. The connection of the cable to the gauge (Fig. 4) could then be made with a crimping tool without exposing the gauge compartment to the atmosphere. The cable was fixed and sealed by a cable gland with an internal crimping ferrule, the gland being covered by a plastic sleeve filled with waterproofing compound.

Fig. 4—Connection of cable to gauge

The detailed arrangement of the gauge is shown in Figs. 1 and 5. The "Paxolin" terminal board, which slides into grooves in the cast iron cover, serves to separate the gauge compartment from the connection compartment and also carries a tube containing silica gel, as a drying agent. The gauge assembly is therefore complete with its electrical wiring before the cover is placed in position, at which stage the "Paxolin" board slides into the grooves, which are filled with "Bostik." A rubber gasket is provided between the gauge cover and the structure ; this serves both to seal the cover and to isolate it structurally from the component to which it is attached. For the same reasons there are also rubber washers beneath the cover fixing nuts, and rubber grommets around the fixing studs. The surface of the girder is painted with a thick rubber sealing compound, to prevent rusting or flaking of the surface. It is essential that the gauge components should be free from loose metal particles before the cover is fixed.

Owing to the congestion of the building site on which the gauges were to be used, the steelwork was available for instrumentation for only a short period before erection, and it was therefore essential that the gauges should be capable of very rapid adjustment and assembly. Experience of investigators using other gauge designs was not encouraging in this respect, assembly rates of three or four gauges per day being mentioned where there was little experience of the gauge's idiosyncrasies. To meet the construction schedule the first forty-two gauges were stud welded, adjusted and completely assembled in two days. Over 100 gauges were fixed to the steelwork before erection, and all were operative after erection of the structure.

Acknowledgments

The writer gratefully acknowledges the assistance and co-operation of Mr. J. Neale and Mr. R. Brannan, of the Civil Engineering Department, Imperial College, at all stages of the development and installation of the gauges. He is also indebted to Mr. R. J. Mainstone, of the Building Research Station, for very helpful discussions at the beginning of the development of the Imperial College gauge.

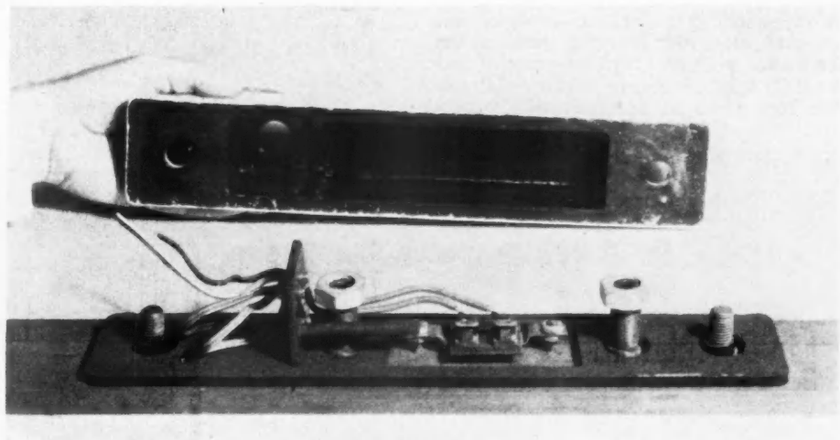


Fig. 5—The assembled strain gauge

Automatic Layshaft Gear Cutting Line

A fully automatic, 175ft long machine line, on which all the four gears of a motor-car gearbox layshaft are cut and checked, has been developed and built by Churchill Gear Machines, Ltd., for a British manufacturer. In this line there are eighteen gear cutting and finishing machines with four inter-operational washing stations, and three automatic gauging equipments. The machines are linked together by work transfer conveyors from which the components are automatically loaded and unloaded at the machines.

AN interesting production line on which all the machining operations on the four gears of a motor-car gearbox layshaft are carried out and checked has been developed and built by Churchill Gear Machines, Ltd., Blaydon-on-Tyne, Co. Durham. This line might well be considered a natural development of the cluster gear cutting lines made by the firm and described in our issue of September 20, 1957. Its general arrangement and the operations performed at the various stations can be seen in the diagram we reproduce in this page. On this particular line the full use of automatic cycle machines coupled with automatic loading and unloading and transfer between stations with interoperational checking reduces the need for operators to a minimum. The parts are prevented from coming into contact with each other during transfer to avoid damage to finished surfaces, and the transfer system allows any machine to be stopped for adjustments or cutter changing without need for halting the remainder of the line. The machines on this 175ft long line are connected by two standard types of conveyors, one for handling the layshafts in the vertical and the other for handling them in the horizontal position. On the transfer and loading side of the installation full use has been made of the hydraulically-operated transfer arm described in our previous article, and of the firm's more recently introduced reciprocating auto-loader when the layshafts are handled in the horizontal instead of the vertical position.

The line begins with the series of five Churchill "Rigidhobbers," shown at the top of the page. The first two of these machines hob the fourth speed gears on the layshafts, the second two the third speed gears and the fifth the first speed gears. Two machines are used for the larger diameter helical fourth and third speed gears to maintain the required production flow in subsequent machines, where the actual cycle time on individual layshaft operations are shorter. These pairs of machines take shafts from the incoming feed line and the system of feed is shown in the diagram, Fig. 2. At the first machine hobbing the fourth gear a small storage bank of layshafts is built up by deflector plates on

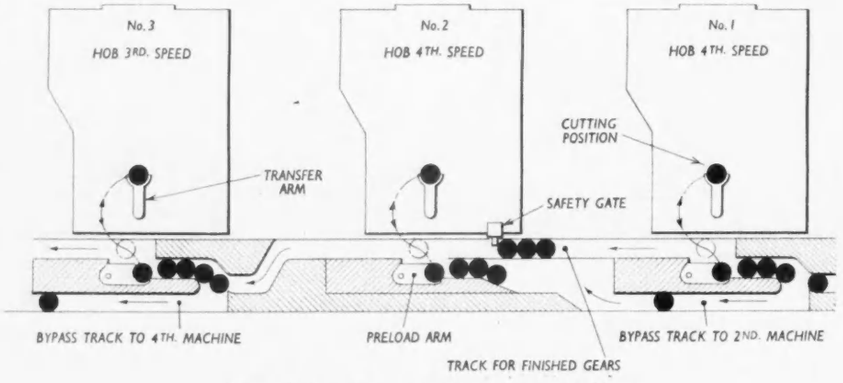


Fig. 2—Diagram showing feed of gears to hobbers

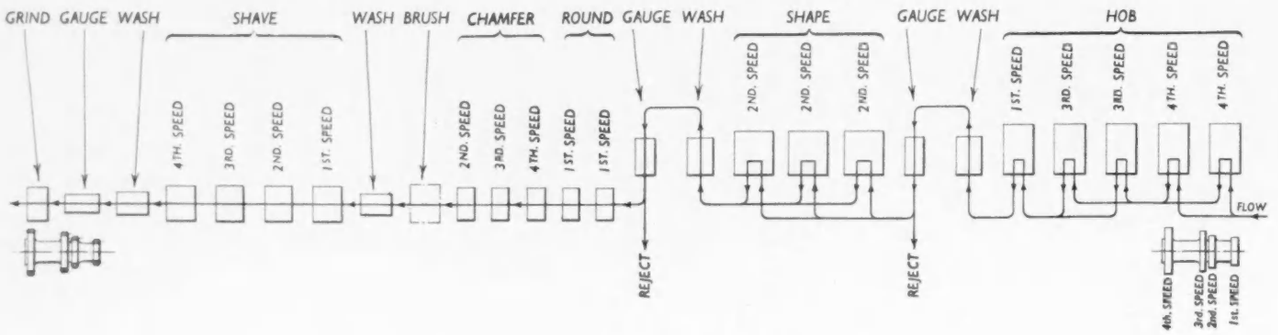


Fig. 1—Schematic layout of automatic gear cutting line

the conveyor immediately in front of the loading gear of the machine. Further incoming components are deflected to the outer side of the conveyor and carried to the second machine, again forming a small bank.

The first component to reach the bank at a machine moves into the preloading arm shown in Fig. 3. As the component passes into the yoke of the preloading arm a microswitch is actuated and starts the automatic machine cycle. The arm slides the layshaft across to the inner side of the conveyor to a point where it is picked up by the transfer arm and placed in position on the machine. After a predetermined delay the pre-loading arm returns to its central position on the conveyor, and another component is carried into it ready for the next cycle. When the gear has been cut the transfer arm returns the layshaft to the inner of the three tracks into which the conveyor is divided by deflector plates. Layshafts from the first machine of each of the two pairs used for cutting the fourth and third gears are held by a safety gate at the ingoing side of the second machines, until their preloading arms have completed a cycle and have returned to their

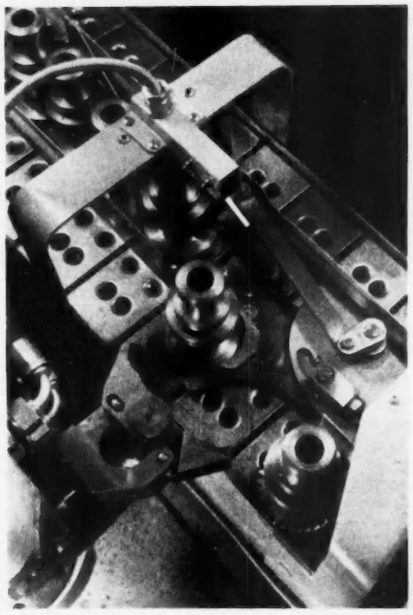


Fig. 3—Component from the conveyor bank at a hobbing machine for fourth-speed gears being carried over by preloading arm to pick-up point of transfer arm. A completed component can be seen moving away from the machine on the inner section of the conveyor

pick-up positions. The gate then automatically opens and frees the layshafts completed on the previous machine to pass on for the next operation.

It will thus be seen that the conveyor system used enables the machines to be individually operated and any one of the five hobbers can be stopped for tool changing without affecting the remaining machines, and each machine cycle automatically starts when a component moves into the preloading arm. At the completion of the hobbing operations the layshafts are carried to the end of the conveyor where they turn over on to horizontal guides along which they roll through a washing unit. In this wash a high-pressure hot chemical spray removes all cutting oil and swarf from the layshafts. The heat of the cleaning liquid and a subsequent air jet drying station dry the layshafts before they roll on, as shown in Fig. 5, to a storage bank leading to a gauging equipment. In this gauging operation the hobbed gears are gauged for size, run-out and lead. The automatic gauging equipment installed at this and two subsequent stations along the line is described at the end of this article.

After cleaning and gauging, the layshafts are passed back in a vertical position on to a conveyor feeding three Fellows gear shapers manufactured by Alfred Herbert, Ltd., Coventry. On these machines, which are fitted with Churchill transfer arms, the second speed gears are cut. The work conveyor serving these machines is arranged on similar lines to that of the hobbing machine group with feed banks and by-pass deflectors. After the second speed gears have been cut the layshafts are again washed and gauged before they pass to a group of three chamfering machines where the helical teeth of the second, third and fourth speed gears are chamfered, and two rounding machines which deal with the straight teeth of the first speed gears. These gear chamfering and rounding machines are the first of a new range of machines designed by the firm around the Churchill auto-loading device.

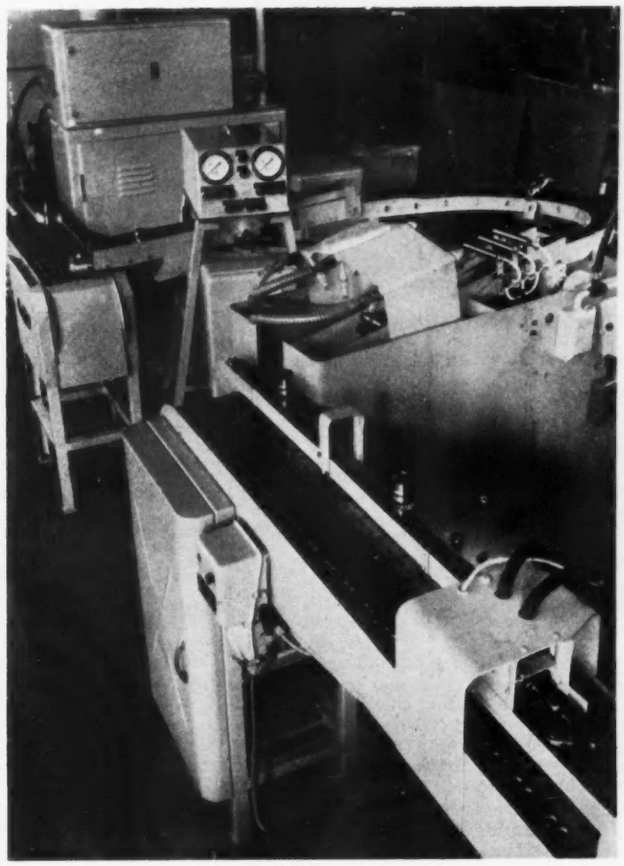


Fig. 5—Spray washing unit in which layshafts are cleaned before gravitating along the chute to the automatic gear gauging equipment at the rear

On the rounding machines, Fig. 4, the layshaft is held between a pneumatically-operated head and tailstock. As the layshaft is turned by the geared headstock it is oscillated in the correct sequence for tooth rounding. One end of the first speed gear

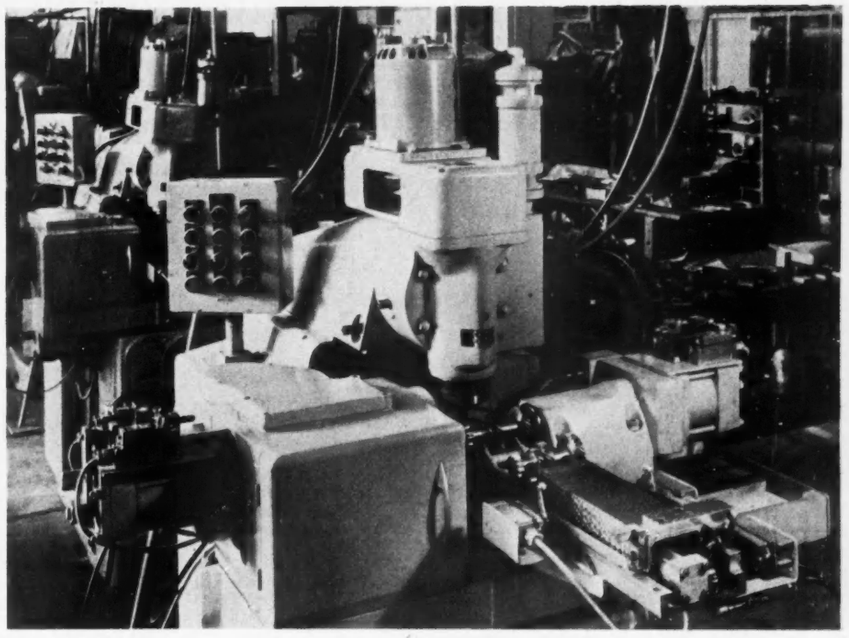


Fig. 4—First-speed gear tooth rounding machine. The transfer conveyor has not been fitted but the auto-loader slide can be seen in position with the next layshaft to be machined in its cradle

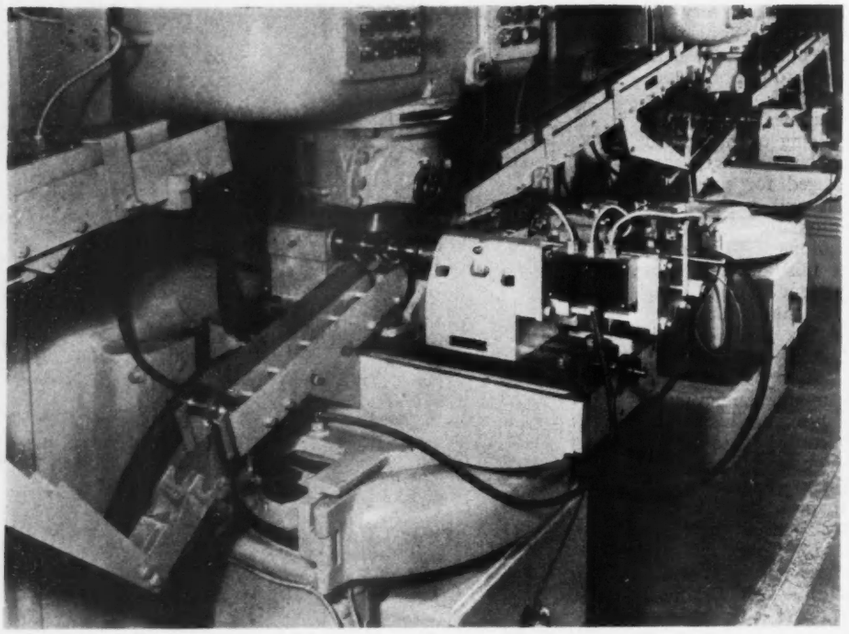


Fig. 6—Shaving machine for the third-speed gear. The transfer arm to the feed conveyor of the subsequent machine can be seen on the left coming up to remove a component from the gravity chute

teeth is rounded on one machine and the opposite ends on the second machine. These machines have a pencil design cutter, carried in a quill, which can be quickly retracted for the automatic loading sequence of the machine. The auto-loading equipment fitted to these and other machines consists essentially of a pneumatically-operated slide which picks the layshafts in turn from the feed conveyor and presents them to the machining position. Its movements are controlled by electrical interlocks on the head and tailstocks of a machine.

Leaving the two gear rounders, the components pass in turn to three gear chamferers which successively remove the acute edges of the helical gears on both sides of the teeth of the second, third and fourth speed gears using rotary chamfering tools. The layshafts are placed into these machines by autoloaders, and are clamped by head and tailstocks similar to those used on shaving machines. They are meshed in backlash with a rotary cutter carried by a cutter head which can be rapidly moved down into full engagement with the gear, under controlled pressure, and then moved quickly to the left and then to the right in order to chamfer both sides of the teeth. After chamfering, the layshafts are discharged through the machine column and elevated to the chute feeding the next machine.

Provision is made in the line between the chamfering section and the subsequent shaving machines for the introduction at a later date of an automatic brushing machine. For the present components are passed through a wash and are then deburred by hand and loaded on to the supply chute leading to the gear shavers, one of which is illustrated in Fig. 6. To provide for the straight line loading of shafts the tables of the gear shaving machines have been turned through 90 deg. The conveyor systems used for the shaving, rounding and chamfering machines provide storage banks for each machine with electrical signalling incorporated to show if a feed chute is empty or full. Each storage bank contains sufficient shafts to enable its machine to run whilst a preceding machine has its tools changed.

When the layshafts leave the shaving section they pass through another wash followed by automatic gauging of all four gears. From this final gauging station the layshafts move on to the loading station of a Newall grinding machine, on which the outside diameters of the three helical gears are ground. This machine is fitted with automatic wheel truing and compensating gear and a new design of pneumatically operated loading equipment. This equipment has a swinging arm which picks up a layshaft from the conveyor and transfers it to the grinding position, where it is released when gripped between the centres. After grinding is completed the layshafts are automatically released by the machine to run down to the end of the production line.

The automatic gauging equipments developed by Churchill Gear Machines, Ltd., for use on this line incorporate Sigma pneumatic heads. In each equipment a constantly driven pneumatic valve mechanism programmes the complete gauging cycle which starts when the component to be checked rolls through an escapement mechanism into the gauging position. At this point pneumatically operated head and tailstocks advance to position the layshaft on the bore chamfers which form the location for all machining operations. Three precision gauging heads, which advance in sequence, then gauge the three gears for size and lead, after which the layshaft is turned twice through 120 deg., the gauging being repeated in each position, thereby checking eccentricity in addition to size and lead.

Pressure angle nose pieces carried on frictionless spindles in the heads have both axial and rotational degrees of freedom and engage the gear teeth along the full face width. Under controlled pressure the gauging heads establish axial and rotational positions, dependent upon the size and lead, and contact Sigma pneumatic gauges which, in turn, pass appropriate signals to an electrical circuit which rejects or accepts the gear.

When the gauging operations are completed the head and tailstocks of the gauging equipment retract and allow the shaft to roll on to the next operation, or, in the case of a reject, into a reject chute. When a preselected number of components have passed into the reject chute an electrical signal is passed back to the machine concerned to stop production.

Programme Train Signalling at Watford

Automatic signalling under the control of programme machines has been installed at the Watford terminal station of London Transport's Metropolitan Line and all train working at that station is now supervised from Rickmansworth some 3 miles away. The new track installation includes, for the first time on London Transport, a new modified design of chairlock point control.

THE mechanical signalling system at the terminal station at Watford on the Metropolitan Line has been replaced by London Transport by a new power-operated installation using programme machines. In this installation one sequence and one time machine are employed and together they carry out the following routing of trains :

(1) The reversal of trains of multiple unit stock in either platform and their dispatch at the correct departure times.

(2) The automatic setting of routes to run the locomotive of a locomotive-hauled train round its train before dispatching it at the correct time.

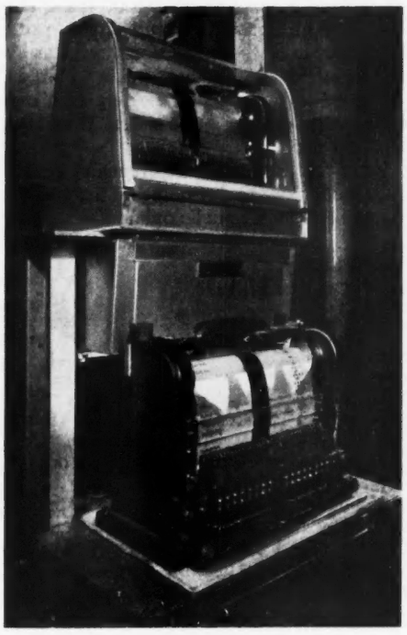
(3) The preparations for the morning service, in which trains are shunted from the electrified sidings to the running line and then reversed into the platform and dispatched at the correct time.

(4) The routing of trains at night and in off-peak periods from the platforms to the appropriate sidings.

In order to deal with any special circumstance outside the normal timetable working at Watford the signalman at Ricksmansworth, who now supervises the working at Watford, is provided with a control panel and has push buttons so that he can route trains at Watford manually should this be necessary. Normally, the programme machines carry out all movements automatically. Although the programme machines have paths for goods trains included in their programme they do not actually set the routes for these trains. Such goods trains are signalled by push button from Rickmansworth, the programme machines merely warning the Rickmansworth signalman, by sounding an audible warning in his box, that the trains are ready to proceed.

The programme machines used by London Transport were described in some detail in connection with the automatic signalling of the Northern Line in our issue of January 17, 1958. Briefly, these machines carry a roll of plastic material on which is typed the details of each train passing over the section of line in sequence. These details are an exact reproduction of the timetable information and include the destination of the train, the train number, and its time. Holes punched between the rows of typing interpret the information contained in the typescript and electrical contacts are actuated through these

holes to control the signalling equipment. Each train that passes causes the roll to step forward so that the electrical contacts read the next required train operation. The carriage containing the plastic roll in the programme machine can easily be inserted into or removed from the machine so that a different programme roll can be used for



Programme machine installation at Watford, showing the sequence machine mounted above the time machine, on which one of the plastics rolls can be seen with the row of electrical contacts

weekday, Saturday or Sunday working. One of the machines can be seen in the illustration on this page.

The layout at Watford consists of an island platform with two platform roads, two adjacent electrified sidings outside the platform roads, and a goods yard. The resignalling work involved the abolition of the mechanical locking frame used previously and the conversion of mechanical signals and points to power operation. The signalbox at Watford has been taken out of commission.

Keys are provided in the Rickmansworth control panel to allow the signalman to "step" the programme machine to the next train position in the event of a train being cancelled, and to allow the departure path associated with that train to be cancelled. Another key will prevent the programme machine from stepping so that an extra train can be handled at Watford without the programme machine getting out of sequence. The extra train must be signalled in and out of Watford under either push button or automatic reversal control as described below.

Apart from programme machine working, facilities for the automatic reversal of trains without regard to timetable operation are provided at Watford. Under this system, the first train to arrive at Watford will be the first to leave, the starting signal being automatically cleared for a train to depart as soon as the platform stop has exceeded four minutes. There are thus three possible methods of operating the signalling at Watford: normal programme machine working; automatic reversal; and, by push button from Rickmansworth.

All signals and points are controlled from shafts in a 36-shaft interlocking machine housed in a new building between the running lines at the south end of the station. The interlocking machine is provided with mechanical interlocking and with contacts for the control of the signalling circuits. Each shaft is equipped with air cylinders and electromagnets energised by the remote control circuits—programme machines, automatic reversal operation, or by push buttons from Rickmansworth. Sealed relays of the telephone type are used for the non-safety circuits operating the interlocking machine shafts. One shaft in the interlocking machine, controlled from a two-position key in Rickmansworth signalbox, is provided for the purpose of isolating the goods yard working, enabling the shunter to set points by hand for shunting purposes without interference with the general station working.

In the signalbox at Rickmansworth, a push button is provided for the control of each signalled route at Watford if required during a disorganisation of the service or in exceptional circumstances. The push buttons are of the standard L.T.E. type which are capable of being illuminated green, yellow or red to show whether the signals are clear, or that the route has been preselected, or that the signals are at danger. An illuminated diagram shows all track circuits in the Watford area together with signal and point indications. Two-aspect colour-light running signals and externally illuminated disc shunt signals are used and junction indicators are provided in accordance with standard L.T.E. practice. Electro-pneumatically operated train stops are provided at all running signals and certain shunt signals.

For the first time on an appreciable scale on London Transport installations, the points will be controlled by the chairlock design of point layout, similar to that employed by the French National Railways but modified and developed to London Transport requirements. The modifications include the provision of an electro-pneumatically operated ground tracklock which is provided on facing points over which passenger trains operate and a detector which separately detects each switch and the ground tracklock in the locked position. Although an experimental point lock of this type has been in use at the eastern end of Earls Court station (District line) since 1954, this is the first time that the production model of the modified design has been used, and we illustrate one of the twelve pairs of points installed at Watford. The essential part of this design is that the closed tongue of the points is held firmly clamped to the stock rail when locked. The actual locking mechanism is enclosed in a casting forming part of the chair which supports the end of the switch tongue, so that there is a separate lock for each tongue. This is in contrast to the usual method of locking in this country, which consists of a plunger acting on the stretcher bar. The drive rod of the layout is connected to two switch locking arms which pivot at each switch.

The locking arms are in the form of cranks, one arm of which is connected to the electro-pneumatic operating cylinder. The second arm is provided with locking faces which engage with corresponding faces in the lock box chair castings to achieve the mechanical locking. Each chairlock is equipped with an electro-pneumatically-operated ground tracklock which has to be lifted to allow the switch locking arm to move and this tracklock is locked by the occupancy of the protecting track circuits. The detection contacts can only be closed (to allow the signal circuits to be completed) when both switches are in the correct position and locked in that position by the ground tracklocks.

The lines are continuously track circuited by single rail condenser feed track circuits. Rail circuits of the 10KC type have been provided to detect that trains passing over facing points have completed their route and that the backlocking requirements have been satisfied. Line cables for connections to signals, train stops, points and track circuits are of the single and two-core rubber compound lead-covered type. Connections between cable runs and track equipment are carried out with the aid of screened multi-core cables with ribbed "Neoprene" sheaths. This class of cable has a metal screen around the insulation on each core, and, because of its ribbed sheath, may be laid on ballast without concrete troughing or similar protection. Ten-core cables of this type are used for connections to points and train stops, and a recently-developed three-core cable is used for signals.

All the work in connection with the modernised signalling at Watford was devised, planned and carried out by Mr. R. Dell, Signal Engineer, London Transport, and his staff to the general requirements of Mr. C. E. Dunton, Chief Civil Engineer, London Transport.

One of the chairlock point layouts installed, showing the electro-pneumatically operated ground tracklock mechanism. The locking mechanism is in the casting supporting the end of the switch tongue and there is a separate lock for each tongue

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

VIBRATION WAVES IN CONCRETE

SIR,—I have read with interest the above article by Mr. Farrar in THE ENGINEER of September 5, 1958, and was puzzled as to the source of the theoretical curves of Figs. 4, 5 and 6. Certainly, they were not derived from the equation published as $A=A_0 \cosh Nx$, which is not a decay curve if $x=0$ at $A=A_0$. I suggest that the equation should read :

$$A=A_0 \cdot \frac{\cosh N(L-x)}{\cosh NL} \quad . \quad . \quad (a)$$

where

L is the total height of concrete,
x is measured from the origin of vibration (base of mould),
A_0 is the acceleration amplitude at $x=0$.

Alternatively,

$$A=A_0 \cdot \frac{\cosh Nx}{\cosh NL},$$

where x is measured from the top surface of the concrete.

So far as can be estimated from Figs. 4, 5 and 6, equation (a) appears to fit the theoretical curves, assuming that the units of N for the given value of 0·06 are inches^{-1}. Since the theoretical curves depend upon the measured values of A_0, it might be expected that the theoretical and experimental curves should coincide at this point in each case. However, this is not so in the published figures.

Equation (a) is a normal form for absorption within a length L. In general, the equation

$$A=A_0 \cdot e^{-Nx} \quad . \quad . \quad . \quad . \quad (b)$$

is accurate enough for the consideration of the behaviour of vibration waves in fresh concrete. In addition, it is more readily applicable, not only to table vibration but also, with slight amendment, to other forms of vibration.

Experiments have been made,[1] using the ultrasonic pulse method on specimens cast, at various amplitudes, on a vibrating table operating at 6000 vibrations per minute. From these, the value of N was deduced to be approximately 0·10in^{-1}. The discrepancy between this value and that found by Mr. Farrar (0·06) may be explained by :

(1) The difference in mix.

(2) The difference of frequency of vibration. Mr. Farrar has not mentioned the possible influence of frequency upon damping but, if the behaviour of vibration waves in concrete accords with other materials, N may be expected to increase with frequency. Further experimental evidence is needed to clarify this point.

(3) The essential difference in the methods of assessment of N. In the tests described in reference 1, vibration continued for only one-and-a-half minutes. In Mr. Farrar's tests, no useful observation could be made during the period of greatest practical interest, i.e. when compaction was actually taking place.

To the best of my recollection, no mention has been made in the articles of Dr. Plowman and Mr. Farrar of the work of other experimenters in this field, most of whom have used the same method of measurements on buried accelerometers during vibration. Principally, Mary,[2] Pigman *et al.*,[3] Bergstrom and Linderholm,[4] using internal vibrators and Kirkham and Whiffin,[5] using surface vibration, are worthy of mention. For the circular propagation of vibration waves into concrete which applies both to internal vibration and to surface vibration, using a vibrator mounted on a beam, equation (b) modifies to :

$$A=\sqrt{\frac{x_0}{x}} \cdot A_0 \cdot e^{-N(x-x_0)} \quad . \quad . \quad . \quad (c)$$

where x and x_0 are measured from the centre of the circle. Values of N calculated from the results of references 2, 4 and 5, using equation (c), give values of N in the range 0·04in to 0·18in^{-1}. The influence of frequency is not at all clear from these results.

I must apologise if the main point of my letter (the correction of the decay formula) has already received the necessary attention. A price we pay here for sunshine is a four to six-week delay in the arrival of current periodicals.

A. R. CUSENS

University of Khartoum,
Faculty of Engineering,
October 10, 1958.

REFERENCES

[1] Cusens, A. R., Ph.D. Thesis, University of London, 1955, and "The Influence of Amplitude and Frequency in the Compaction of Concrete by Table Vibration," *Mag. of Concr. Research No.* 29, August, 1958, pages 79–86.
[2] Mary, M., "Etude de la vibration du béton." *Ann. d. Ponts et Chauss.*, 1936, pages 338–365.
[3] Pigman, G. L., Hornibrook, F. B., and Rogers, J. S., "A Portable Apparatus for Measuring Vibration in Concrete," *Journal of Res. Nat. Bur. Stds.*, Vol. 20, May, 1938.
[4] Bergström, S. G., and Linderholm, S., "La vibration du béton. Recherches experimentales," *Svenska Forskningsinstitutet för Cement och Beton*, Meddelanden, N.R. 18, 1949, 80 pages.
[5] Kirkham, R. H. H., and Whiffin, A.C., "The Compaction of Concrete Slabs by Surface Vibration," *Mag. of Concr. Research*, No. 8, December, 1951, pages 79–91.

CLEAN AIR AND PUBLIC OPINION

SIR,—May I emphasise the national importance of the last sentence of your editorial "Cleaning the Air" : "For without the support of public opinion, the Clean Air Act, or any other Act of the future, must prove abortive."

We could have had the equivalent of the Clean Air Act thirty years ago if there had been a public opinion strong enough to put into action the proposals of the leading technical authorities of those earlier days. We then had the necessary knowledge and experience to do just what we are doing to-day. Apart from the continuous work of the National Society for Clean Air, the earlier years of the Institute of Fuel were directed to a national fuel policy. The leading authorities in fuel technology directed their minds to this problem and a mass of evidence was produced to show the national need for a fuel policy that would both economise fuel and reduce atmospheric pollution, and, incidentally, save millions in money value. This work was very fully reported in the technical Press over a number of years, but there were no signs of any public movement. It was not until the heavy death roll during the smog of 1952 that public opinion awakened to the need for dealing with our fuel problem on a scientific basis. The Clean Air Act followed.

Your last sentence, Sir, remains simple truth, but are we to-day doing all that should be done to educate public opinion ?

JOHN D. TROUP

Purley, Surrey,
October 14, 1958.

Book Reviews

The Junction Transistor and Its Applications. Edited by E. WOLFENDALE, B.Sc. (Eng.), A.M.I.E.E. Heywood and Co., Ltd., Ingersoll House, 9, Kingsway, London, W.C.2. Price 84s.

THIS book is, in effect, a collection of papers written by a team of physicists and engineers of the Mullard Company, with several years' experience in the field of semi-conductors, the editor himself being at present the chief semi-conductor applications engineer. It is intended for engineers, physicists and students as a comprehensive introduction to the junction transistor and its applications.

The first chapter, "Transistor Physics," by T. B. Watkins, is intended for the physicist and experienced circuit designer. It deals at some length with the fundamentals of semi-conducting crystals which are followed by the theory of the ideal P–N junction and P–N–P transistor in each case a complete equivalent circuit being developed. There is then a section on the main additional effects which have to be considered in order to explain the behaviour of a real transistor. Lastly, there is a section on noise. For the physicist this chapter will probably be adequate but for even the experienced engineer probably rather heavy going due to the omission of a list of symbols and the presence of a few obscure and sometimes incorrect statements. To quote an example the valence electrons in a semi-conducting crystal are said to have to break free from the covalent bonds in order to move through the crystal, implying that the valence electrons are normally fixed in space.

Chapter 2, "Characteristics," by E. Wolfendale, deals with the basic physics of the transistor leading to the basic properties of the transistor as a circuit element in reasonably simple terms. The same final equivalent circuit as in Chapter 1 is developed and there are sections on hole storage, the effect of d.c. operating point and temperature on characteristics, together with a section on noise. The chapter, on the whole, seems ideal for the beginner, but the subject of noise is made difficult by no mention of signal-to-noise ratio, and, hence, the conclusion that the measured noise figure is misleading in the case of large mismatch between source and input. Also, there is no mention of turnover voltage, which, incidentally, is treated in Chapter 1, but not in terms of practical transistors.

In Chapter 3, "General Four-Terminal

Networks and the Transistor Equivalent Circuit," by L. E. Jansson and E. Wolfendale, the various types of four-terminal network are evaluated in terms of their circuit performance. Using these results and starting from the fundamental equivalent circuit derived in Chapters 1 and 2, the various well-known practical equivalent circuits are developed with a rough assessment of their limitations. This chapter should again be ideal for the beginner.

Chapter 4, " Direct Current Biasing and Audio Frequency Amplification," by L. B. Johnson, deals first at some length with the various methods of biasing, the stabilising factor against variation of transistor parameters, thermal run-away, choice of working point and adjustment of biasing circuit. The next section deals with small signal A.F. amplification and commences with graphs for a typical transistor of variation of input and output impedances against load and generator impedances for the three circuit configurations. The simple circuits in which load is small compared with transistor output impedance are considered as well as the basic limitations of frequency response. Finally, in this section, negative feedback is considered. But, unfortunately, no mention is made of frequency response or stability against oscillation. There is then a useful section on power amplifiers followed by a worked example of the design of a 200 milliwatt amplifier which is complete except that no mention is made of frequency response or, again, of stability even though there are two transformers in the feedback loop.

Chapter 5, " High Frequency Amplification," by L. E. Jansson, deals with the design of narrow band amplifiers using local feedback to provide neutralisation. The common emitter and common base arrangements are analysed in terms of the appropriate equivalent circuit. Full treatment, however, is given only to the common emitter arrangement as this is the most widely used, there being sections on stability considerations and a worked example on the design of a 470 kc/s I.F. amplifier. The chapter as a whole should be very useful for design purposes, but there is an unfortunate attempt to show, by incorrect use of the calculus, that the value of load required for maximum power transfer from a transistor is unaffected by the losses in the tuned circuit in shunt with the load. However, this error only invalidates the subsequent design considerations to the extent that the working power gain is reduced by a few decibels below maximum.

Chapters 6, 7 and 8 are entitled " Class C Amplification," " Sinusoidal Oscillators " and " Amplitude Modulation and Demodulation," all being contributed by L. G. Cripps. They are fairly brief, but contain much information especially in the form of practical circuits.

In Chapter 9, " The Junction Transistor in Non-Linear Circuits," by L. P. Morgan and W. L. Stephenson, there is a full discussion of the design of bi-stable circuits, multivibrators, blocking oscillators and triangular waveform generators. Finally, there is a short section on the use of transistors with square loop ferrites.

Chapter 10, by L. H. Light, is entitled " Transistor D.C. Converters." The actions of two basically different types of circuit are described in detail with reference to particular circuits and refinements such as voltage multipliers, stabilisation and protective circuits are discussed. There are general design considerations and a worked example of the design of a typical converter giving 4W output and a table is given of the main details of nine practical converters whose outputs range in power from 3 milliwatts to 260W.

Finally, there is an appendix on " Transistor Measurements," by J. E. Greengrass, which is concerned mainly with circuits for measurement of the seven parameters of the full T-equivalent circuit developed in Chapter 1. Also, there are circuits for measurement of noise figure and large signal output characteristics under pulse conditions and a note on estimation of junction temperature. The main criticisms are that the circuit claimed to measure C_{drp} in fact measures C_c and that no explanation is given for the requirement of small emitter current in the measurement of μ. Also, perhaps in his desire for brevity, the author seeks to dismiss some of the four-terminal network measurements with the aid of objections which appear quite unfounded.

In conclusion, it can be said that this book contains a large amount of useful information on the theory and applications of the junction transistor and is mostly well written and laid out. However, the reader should be aware of the errors and obscurities pointed out above in addition to which were noticed ten rather obvious mistakes which evidently survived the proof-reading stage. It has the advantage of being probably the most comprehensive book of British origin in this field and in price and most of the subject matter compares favourably with the best of similar American books.

Pre-Stressed Concrete. By R. H. EVANS and E. W. BENNETT. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 60s.

THIS latest book on prestressed concrete is essentially a textbook for students. It is divided into three parts : analysis of simply supported beams, their design, and, lastly, special applications. In the first section is set out the properties of the materials used, their behaviour, and that of prestressed concrete under different loading conditions. Here will be found with much experimental evidence the fundamentals of the subject—the reasons behind the assumptions made and it gives an excellent groundwork. It is perhaps a pity in this section that the work of the Cement and Concrete Association on transmission length, which, on one point, contravenes the authors' results and the work of the Building Research Station on ultimate and fatigue strength, has not been mentioned.

The second section, although covering the ground, is not so clearly presented and contains too many symbols for the everyday designer, although it is excellently supported by an appendix giving the properties of various unsymmetrical sections. In the third section are to be found very many applications of prestressing, including, among others, composite construction, indeterminate structures, liquid retaining structures, domes and shells. This section is by no means a complete treatise on all these applications, but references are given to further information. In this section the practical details are often lacking or described without critical comment, but provided the reader is prepared to treat these as a guide rather than as a final solution he will find much of interest in this section.

Although the authors have the student in mind the design engineer may find many profitable chapters in this well-produced book particularly on the fundamentals of the subject.

Handbook of the Collection Illustrating Motorcycles : Part II, Catalogue of Exhibits with Descriptive Notes. By C. F. CAUNTER. H.M. Stationery Office. Price 7s. 6d.

PART I, *Historical Survey*, of this Science Museum publication was reviewed on October 5, 1956 (page 474) under the title " The History and Development of Motorcycles." It is regrettable to have to observe that the collection does not do justice even to the British contributions to this fascinatingly difficult branch of engineering. The text is very right in describing the " C.S. 1," misprinted " C.S.I," as one of the early examples of a single-cylinder engine with an overhead camshaft, and we still believe that the National Collection is seriously incomplete while it is without an example of the successor to that engine, the history of which, as the " 30 " and the " 30M," is replete with glory. Nor is there an example of a desmodromic engine, such as is raced by Ducati, or of a fuel injection engine, such as is to-day favoured by B.M.W. on slow circuits where the engine may be called on to deliver widely varying torques over an extreme speed range.

The catalogue too is disappointing. The " Manx " engine of late years has been surpassed by foreign designs which the industry in this country believes to be unsaleable. The main reason why it has remained a force to be considered in racing is the " Featherbed " frame to which it has been wedded, and that frame, in its excellence and its influence on other makes, is this country's major contribution to the present state of the art. But this handbook considers frames insufficiently important to merit a chapter, and groups them with accessories. And this chapter is not only ill-conceived but also poorly executed, for the illustrations of Brampton and Druid forks should be transposed.

Books Received

Automatic Measurement of Quality in Process Plants. Butterworths Scientific Publications, 4 and 5, Bell Yard, London, W.C.2. Price 50s.

Dilogarithms and Associated Functions. By L. Lewin. Macdonald and Co. (Publishers), Ltd., 16, Maddox Street, London, W.1. Price 65s.

The Motor Vehicle. Sixth edition. By K. Newton and W. Steeds. Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 45s.

Reinforced Concrete Design. 2nd Edition. By W. Morgan. Edward Arnold (Publishers), Ltd., 41, Maddox Street, London, W.1. Price 28s.

The Principles of Technical Electricity. Third Edition. By M. Nelkon. Blackie and Son, Ltd., 17, Stanhope Street, Glasgow, C.4. Price 15s.

Examples in Technical Drawing. By Raymond S. Forbes. B. T. Batsford, Ltd., 4, Fitzhardinge Street, Portman Square, London, W.1. Price 10s. 6d.

Electrical Principles. Second edition. By H. Cotton. Cleaver-Hume Press, Ltd., 31, Wright's Lane, Kensington, London, W.8. Price 12s. 6d.

Technische Laufwerke Einschliesslich Uhren. By F. Assmus. Springer-Verlag, Reichpietschufer 20, Berlin W. 35, Western Germany. Price DM.36.

Rigid Frame Formulas. 12th Edition. By A. Kleinlogel. Crosby, Lockwood and Son, Ltd., 26, Old Brompton Road, London, S.W.7. Price 90s.

Optimale Stufenrädergetriebe für Werkzeugmaschinen. By E. Stephan. Springer-Verlag, Reichpietschufer 20, Berlin W. 35, Western Germany. Price DM.21.

Land Surveying and Levelling. By Ian Robb. The Association of Engineering and Shipbuilding Draughtsmen, Onslow Hall, Little Green, Richmond, Surrey. Price 3s.

Welding Aluminium Alloys. By J. H. Green. The Association of Engineering and Shipbuilding Draughtsmen, Onslow Hall, Little Green, Richmond, Surrey. Price 4s.

Experimentelle Untersuchungen an Verschieden Stark Konvergenten, Schalken Rotationskörpern bei Massig Hohen Uberschallgeschwindigkeiten. By Hans Rudolf Voellmy. Verlag Leeman AG., Arbenzstrasse 20, Postfach, Zürich 34, Switzerland. Price Sw.F.17

Blind Landing of Aircraft

Last week there were given demonstrations of the work of the Blind Landing Experimental Unit, a department of the R.A.E. located at Bedford. A system of automatic approach and landing has been evolved, and used over 2000 times, which has the advantage of being composed principally of existing aircraft equipment : in its present form, however, it would not satisfy civil standards of safety in operation.

THE Blind Landing Experimental Unit (B.L.E.U.) is the department of the R.A.E. engaged upon the research and development of aids to enable aircraft, whether military or civil, to land at an intended destination, irrespective of weather conditions. Despite advances in the military field, the absence of a safe and successful blind landing system remains one of the outstanding problems confronting civil operators to-day. There have been significant improvements in bad weather aids over recent years, but low cloud base and reduced visibility still impose a very serious limitation on present-day aviation.

Towards the end of the last war, isolated developments towards improved approach and landing facilities were in progress, both at the Telecommunications Research Establishment, Malvern, and at the Royal Aircraft Establishment, Farnborough. In 1945, specialist technical groups from Malvern and Farnborough were combined at Martlesham Heath in Suffolk to form the Blind Landing Experimental Unit, using for their experimental programme the excellent runway and approaches provided by the wartime emergency landing strip at Woodbridge. The unit remained at Martlesham Heath until April, 1957, when it moved to Bedford, following the completion of the main runway (see page 21, July 5, 1957).

Equipment is currently available which allows approaches to be made with an automatic pilot flying the aircraft down a radio beam to a height of about 150ft above the ground, the pilot needing only to take over for the final landing, using the approach lighting pattern for visual guidance. The main programme of the B.L.E.U. is aimed at eliminating this final visual phase of the landing and devising techniques for landing completely blind, and we shall describe first a system in which the aircraft is landed completely automatically, the pilot fulfilling the role only of monitor. It has been used in over 2000 landings, on both propeller and jet aircraft, and in none has the aircraft been damaged.

The system obviously demands an auto-pilot, which, in the demonstration, is similar to the Smith's S.E.P.2 civil auto-pilot, into which is fed guidance information.

There are several phases of guidance during an automatic approach and landing, namely, glide (I.L.S.), magnetic leader cable, attitude and radio altimeter. Their use is summarised in the table.

The I.L.S. used in the demonstration equipment is the Pye instrument landing system. The tolerance allowed in the I.C.A.O. specification between the I.L.S. azimuth guidance (localiser) and the runway centre line is too great for automatic landing and so, although the Pye system is more accurate than the allowed tolerance, azimuth guidance to the autopilot is switched to a magnetic leader cable system at a height of about 300ft.

The glide path aerial system used in the demonstration has been redesigned to give improved performance below altitudes of 150ft. The new design offers the following advantages :—

(1) Reduction in coupling between the lower and upper aerials, making setting-up adjustments easier.

(2) Reduction in vertical polarisation.

(3) Reduction in back radiation from the lower aerial.

(4) Improvement in the amplitude compensation necessary to maintain a linear glide slope at low altitudes, at which the approaching aircraft subtends an increasing azimuth angle to the transmitted beam.

These improvements have been achieved by the use of slot transmitting aerials in place of the original dipoles. At an angle of 45 deg. to normal the lobe of the lower (90 c/s) aerial is 3·0 dB wider than that produced by the upper (150 c/s) aerial ; this meets the requirements for maintaining the amplitude compensation as mentioned in (4) above. In comparison with the dipoles with reflectors, there is an increase of from 2 dB in the forward gain of the redesigned slot aerials. Low wattage heaters have been fitted in the slot cavities to prevent condensation, the power requirements for each aerial being 40W, fed from the unregulated mains supply.

The magnetic leader cable installation, developed by Murphy Radio, consists, on the ground, of two cables situated about 250ft on either side of the runway centreline and extending from about 5000ft beyond the threshold in the undershoot area to as far along the runway as azimuth guidance is required during the ground roll. Each cable is fed from an alternator at a different frequency, the current being kept constant by an electronic control circuit. The magnetic fields from these cables are detected in the aircraft by a small rotating loop, and their value is compared in a simple receiver. This allows position relative to the runway centreline to be determined to better than 5ft.

TABLE

Nominal height, feet	Phase	Guidance	
		Azimuth	Elevation
Circuit to 300	Glide	I.L.S. localiser	I.L.S. glide path
300 to 150 ...	Leader cable	Leader cable ...	I.L.S. glide path
150 to 60 ...	Attitude ...	Leader cable...	Rate gyro
60 to 20 ...	Flare	Leader cable...	Radio altimeter
20 to 0... ...	Kick-off drift	Compass ...	Radio altimeter
0	Ground run	Leader cable, compass	—

At a height of about 150ft, the I.L.S. glide path signal may become unreliable, and so at this height the signal is switched out automatically by the radio altimeter, and the aircraft maintains the average attitude it has adopted during its approach from circuit height. This condition is maintained only for a brief period, until a height of about 60ft, when the radio altimeter initiates the final flare-out.

The radio altimeter is of the frequency-modulated type. It is a variant of the S.T.R.30, called S.T.R.30B, specially modified by Standard Telephones to a B.L.E.U. specification. It not only provides a very accurate measurement of height above ground, but also can detect a change of height of not more than 2ft, and can therefore produce a signal accurately proportional to rate of change of height. These properties are used from a height of about 60ft, to control pitch attitude so as to make the rate of descent proportional to height, i.e. the lower the height the smaller the rate of descent. This gives a very smooth flare-out, and is used right down to touchdown.

At about 20ft, the final switching action takes place, to kick off any drift due to cross-wind. Leader cable guidance is disconnected, the wings are levelled, and rudder is applied to change the aircraft heading to that of the runway (preset on the gyro compass by the pilot at the start of the automatic landing).

When the aircraft touches down, the pilot disconnects the automatic control by pressing a button on the control column. The aircraft is steered manually and brought to a halt using information from the magnetic leader cable presented on the instrument panel.

An important feature of the system is that during all phases of the automatic landing, monitoring signals are displayed on the normal flight instruments. In the demonstration, these formed part of the Smiths' Flight System. The only additional instrument is a sequence indicator which displays the successive phases of the landing.

The final component is the automatic speed control. This controls the throttles automatically so as to maintain a constant preset speed during the approach until

flare-out, when the throttles are closed to safe idling speed in a prescribed manner.

Assuming an autopilot will be carried in any case, the system requires the following additional equipment in the aircraft : Control box and sequence indicator ; automatic speed control ; leader cable receiver and aerial ; low level radio altimeter and aerial. In the single channel equipment demonstrated they represent a weight of about 100 lb.

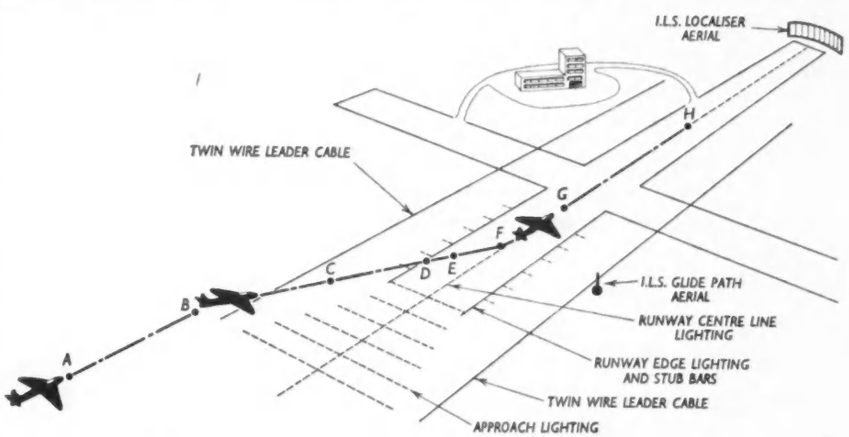
For a more detailed description of the functioning of the system the procedure for a typical landing will be followed. Before approaching the aerodrome, the pilot will set the bearing of the runway in use on to his heading selector : because this heading is reached when drift is kicked off at touchdown, setting up this instrument is a vital action comparable to setting the altimeter before a manual landing.

Assuming that the automatic pilot is flying the aircraft, and holding a constant height, a turn in the direction of the I.L.S. beam is initiated with the rate-of-turn control and radio coupling is selected : the aircraft will then close on the beam at an angle of 60 deg. until the fringe of the beam is reached, when the course will alter smoothly to join the centre of the beam. When the outer marker is reached, the pilot selects " Glide," thereby breaking the height lock, reduces power manually—i.e. quickly—and engages the automatic speed control. This control must be distinguished from the speed maintenance facility of the S.E.P. 2, which by use of the elevators holds the airspeed steady at whatever value pertains when it is engaged, and thereby flies a drift-up cruise. The new control is on indicated air speed and not angle of attack, so the pilot must choose a speed appropriate to the weight of the aircraft ; the machine will obtain and maintain it automatically. From first principles, it might be expected that speed and not rate of climb would be governed with the elevators : in fact, in order to avoid redesigning the automatic pilot extensively to obtain the desirable, but not essential, ability to relieve the pilot of controlling the engines, the new output of throttle motion has been slaved to the new detector of airspeed error. The difference in aircraft behaviour is not significant, since both speed and altitude are continuously and closely controlled, and since the speed demanded will always be well above minimum power speed or even minimum drag speed.

While the aircraft is being flown down the beam, the pilot will use the trim demand buttons to bring the sustained stick forces to zero, as shown by the elevator trim indicator. It will be recalled that when the I.L.S. coupler is used for an automatic approach in civil operations, the automatic pilot is required to be disengaged at such a height that a runaway in the nose-down direction can be stopped and cancelled by the pilot without the aircraft hitting the ground : this limit is usually 200ft on the S.E.P.2. In the automatic landing sequence this safeguard is not possible with the single channel equipment demonstrated. An equipment to meet such a stipulation could be made with triplicated control circuits, but if it remained part of the automatic pilot or flight system, the additional case would arise that a failure during the flight must leave the equipment safe for landing.

Returning again to the aircraft, the azimuth reference will be switched from the I.L.S. localiser to the leader cable system when the aircraft is rather less than 1 mile out. The rotating receiver aerial is housed in a small fairing on the nose, visible in our heading illustration of a Vickers " Varsity." The leader signal receiver is capable of inferring rate of change of error, so that control continues to be on a rate/rate basis. The next change is that the approach coupler is disengaged : the autopilot then reverts to the classical mode of keeping the rate of pitch zero. The wind gradient may act to increase the angle of attack during this phase, but its effect will be reduced by the speed control : in any case, only a few seconds elapse before the flare-out.

The height through the flare-out varies, in theory, exponentially : the vertical speed at touchdown is supposed to be 2ft per second. Late in the flare-out a skid turn is carried out to align the undercarriage with the direction of motion : this turn, like the pitching manœuvres, is governed by an error-sensing circuit, but the system is arranged to apply a predetermined proportion of opposite aileron as the rudder moves.



Phase		Reference	
		Azimuth	Elevation
A—B	Automatic approach (track)	I.L.S. localiser, compass	Barometric height
B—C	Automatic approach (glide)	I.L.S. localiser	I.L.S. glide path
C—D	Automatic land (leader cable)	Leader cable	I.L.S. glide path
D—E	Automatic land (attitude)	Leader cable	Space axes
E—F	Automatic land (flare)	Leader cable	Radio altimeter
F—G	Automatic land (kicking-off drift)	Compass	Radio altimeter
G—H	Manual ground run	Leader cable, compass	—

Automatic landing system

At the very low altitude pertaining it would not be practicable to allow one wing to drop in order to excite a correcting command.

The touch-down feels firm but not heavy : the automatic system reduces power only to flight idle, and makes no attempt to hold off and lose speed before touching down, as a pilot might in conditions of good visibility and ample runway length. There is no direct indication to the pilot how far along the runway he has landed, but he has heard the inner marker announced and knows whether touchdown has been unusually delayed.

It is not possible to give any assessment of the behaviour of the system in practice, on the basis of a few demonstration landings, but the impression gained is that the automatic pilot is mild and deliberate in making corrections ; errors on the cross pointer indicator appear and fade out over tens of seconds. Noticeable it is that at Bedford, where the system is installed in a small number of twin-engined aircraft of light and medium weight, that the black spin-up markings on the runway are clustered closely together. The R.A.E. observations show r.m.s. deviations of 250ft along and 10ft across the runway from a point 400ft inside the threshold on the centreline. It is not expected that larger aircraft with slower responses will touch down much further along the runway.

Blind Landing Research

Research is in progress on other methods of making a blind landing. In one the object is to present to the pilot in bad visibility a picture similar to an airfield lighting pattern seen at night in good visibility. In order to penetrate the fog, a radio frequency must be used, so the concept is that the runway should be outlined by a pattern of radio beacons whose positions relative to the aircraft would be determined by an airborne receiver and displayed on a cathode-ray tube mounted in front of the pilot. This system has been given the name " Televiewer," and when using it in bad visibility the pilot would make a normal landing similar to one he would make in good visibility at night. The system might be considered as an independent monitor to an automatic landing system.

To explore the possibility of landing an aircraft from guidance obtained from a two-dimensional picture of the runway, closed loop television circuits have been installed in a " Devon " and a " Meteor " aircraft. The television camera is mounted in the nose of the aircraft and the cathode-ray tube monitor in front of the second pilot. Many night landings have been made using television pictures of a runway lighting pattern, and the essential requirements of the picture, such as field of view and static resolution, have been defined.

We understand that it has proved possible for a pilot to fly on a presentation degraded in definition and having only a very small included solid angle, and a communication link capable of furnishing the necessary information in bad weather is being designed.

Visual Aid Research

Although the greater proportion of the work of the B.L.E.U. is directed towards developing blind landing systems the more immediate problem of assisting the pilot in the manual landing of his aircraft following an instrument approach is not neglected. The automatic landing system as at present

in existence is, as explained above, incompatible with present standards of safety, and in any case the need to secure international acceptance of a single system must place its introduction years hence. Consequently, the problems of the transition from instrument to visual references remain pressing. For the investigation of such problems with no danger and relatively little expense, the unit has a simulator built by Air Trainers, Ltd., which allows various lighting patterns to be presented realistically to a pilot, and which includes an analogue of a real aircraft to ensure that the displays move according to the control displacements effected. The presentation is by an optical projection technique, the patterns of lights being made by holes 0·004in or 0·002in diameter in metal sheets. The plates are rotated and traversed in their own plane, and the screen on to which they are projected is moved towards the pilot : rolling motions are rendered apparent by rotating a prism in which the light passing to the pilot experiences total internal reflection. This simulator is limited to systems in which the lights are arranged in one plane.

One of the approach lighting systems recently evolved by B.L.E.U. was described on page 291, August 22, 1958. Another system, which adds lateral alignment to glide path indication, was displayed at Bedford. It utilises lights at two levels : at each side of the runway there is a bar at ground level near the touch-down point and a bar at the top of a frangible post near the threshold. When the bars form a straight line the aircraft is on the glide path : when the far and near lights are in symmetry—the two sets are of different colours—the aircraft is lined up with the runway. The bars, being horizontal, give roll guidance in addition.

Mechanical Printings and Newsprint Machine at Aylesford

At the Aylesford Paper Mills, near Maidstone, Kent, of the Reed Paper Group there has been put into commission recently a new mill, No. 13 machine, forming part of the Group's development programme. The machine, of which we illustrate the wet and dry ends, operates at 2000ft per minute and produces mechanical printings and newsprint at a trimmed width of 214in.

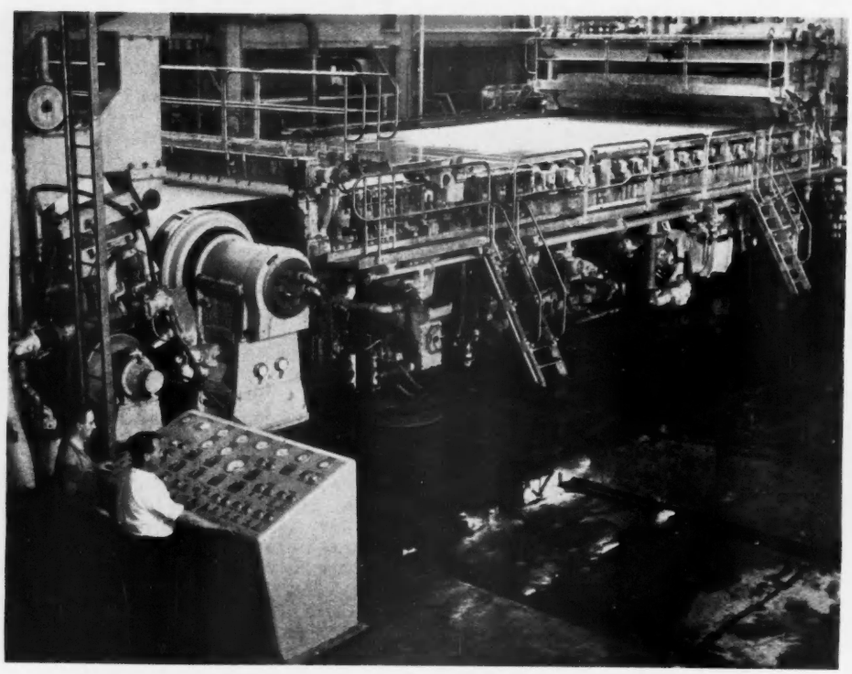
ANOTHER phase in the development and expansion programme of Albert E. Reed and Co., Ltd., has been marked with the completion of No. 13 machine at the Aylesford Paper Mills. This machine, which has been designed to produce a large tonnage of mechanical printings and newsprint at a trimmed width of 214in, has an operating speed of 2000ft per minute, and to maintain quality at a high output rate, instrumentation and automatic controls have been extensively employed, the main control point being a sound-proofed, air conditioned room located at mid-length of the machine and illustrated herewith. Design and manufacture have been carried out by Walmsleys (Bury), Ltd., in collaboration with the Engineering Division of the Reed Paper Group, while the engineering staff of the mills has been responsible for the installation work. Electricity is supplied from an 11kV ring main system; steam for various purposes is provided at 20 lb per square inch gauge from existing pass-out turbines, and the condensate is returned to the boiler house hot well.

The installation of the new machine has called for additional raw materials storage as well as extra Vaughan cranes for handling the baled pulp. This is discharged on a high level unloading platform and handled by squeeze clamp trucks delivered by two slat conveyors, 6ft 6in wide, to two 20ft diameter hydrapulpers, each driven through hypoid gears by a 350 h.p. motor. These are housed in a separate building, one being for ground wood pulps and the other for chemical pulps, but either can be operated on a mixed furnish to keep the machine operating at reduced speed in the event of one of them suffering a mechanical breakdown. After slushing the pulp, which has a 6 per cent fibre content, passes to a soak tank; there are two of 24,000 cubic feet capacity fitted with two 60in double cluster horizontal propeller agitators. The hydrapulpers, hydrafiners, and other equipment were provided by Black-Clawson International, Ltd.

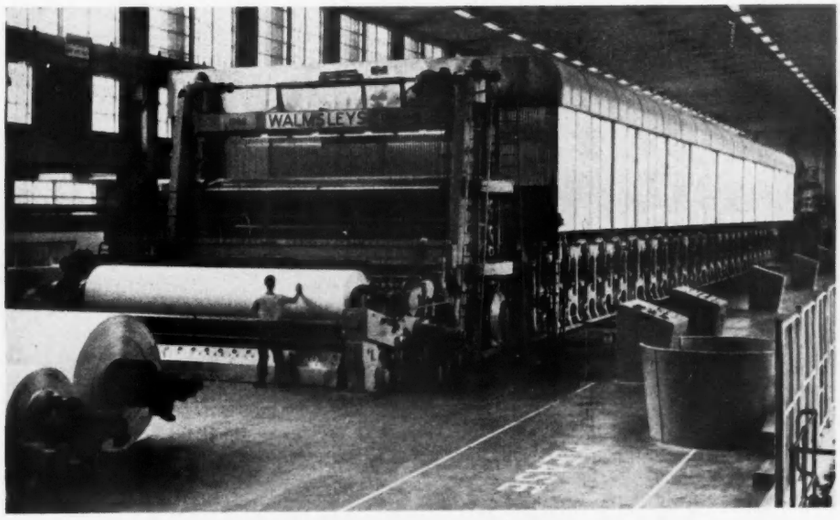
On its way to the day chests the stock is pumped through hydrafiners which are arranged for series/parallel operation by means of Hope rotary valves. Of the six hydrafiners, three operate on ground wood, one on broke and two on chemical pulps. Level recorder controllers in the day chests govern the throughput of the hydrafiners by automatic valves. Controlled quantities of the various stocks, dyes, &c., are admitted to the blending chest and pumped continuously to the machine holding chest, where size is added, and then via two Jordan refiners to the refiner headbox and, diluted down to a fibre content of 0·5 per cent, on to the machine. Duotrol mechanical leads ensure that the unit will shut down in the event of stock failure, while a viscosity pipe pattern controller maintains consistency. There are two stock cleaning systems incorporating primary and secondary vortraps.

The machine has a Beloit pressure flow box, a run-out wire part 228in wide, with a 54in diameter cantilevered couch roll and 32in diameter forward drive roll. The stainless steel wire part has twenty table rolls, seven stainless steel vacuum boxes, one forming board, a 36in diameter driven Dandy roll, and one Beloit air-actuated wire guide. Forming the press section of the machine is a Millspaugh suction pick-up roll, a transfer press suction roll with a rubber-covered top roll, two suction presses with granite top rolls, and a smoothing press consisting of a Neoprene bottom and a bronze top roll. A belt conveyor carries the broke to a point where it can be fed by a screw conveyor into the couch pit. Ten Holmes Connersville blowers arranged in five double units provide the vacuum. In the dryer there are forty-nine drying cylinders, one sweat dryer and ten felt dryers, all of 5ft diameter, oscillating doctors being fitted to the bottom cylinders and the first ten top cylinders. A Carrier-Ross hood, 100ft long by 32ft wide, is fitted and the moisture-laden air is exhausted and discharged through ducting at roof level by eight fans, while steam for drying is handled by a Reiss circulated steam and condensate system. A Ross Grewin vapour absorption plant delivers air at high temperature to nozzle pipes on each side of the machine and the air, at high velocity, passes across the face of the dryers. In addition to the hood fans, there is an extraction fan over the wire part and, to balance this extraction, air is supplied to the mill by a number of units.

The paper leaves the dry part and passes through the machine calender, which is an eight-roll stack provided with a spray cooler, the cooled air being distributed through high velocity nozzles on to the calender rolls. A Duplex solvo pulper, which is completely automatic in operation, deals with the broke

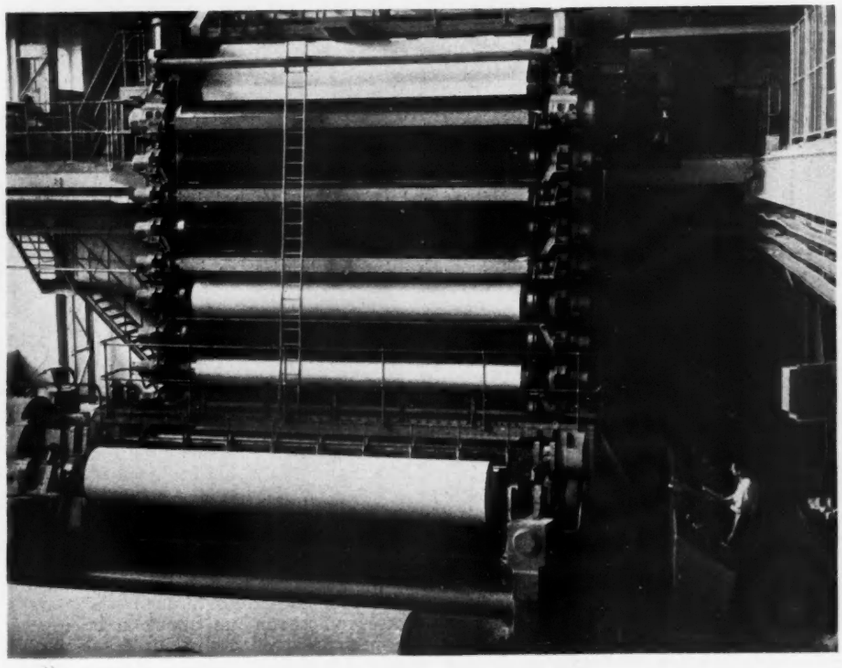


Wet end of machine showing head box, wire section and part of vacuum pick-up



Dry end of machine showing drying section

Air conditioned and sound proofed control room



Ten-bowl stack super calender incorporating a Kohler flying splicer

at the dry end of the machine and when stock and consistency are correct, it is pumped to the couch pit. There is a ten-bowl stack super calender, seen in our illustration, designed for a speed of 2500ft per minute and built by Walker Brothers (Wigan), Ltd., and incorporating a Kohler flying splicer. This enables a second reel to be loaded in the unwind stands, while the first reel is running down, and a join to be made in the paper at a speed of about 1000ft per minute, so that the calender can operate continuously. The Jagenberg winder, which is of overfeed pattern and has an operating speed of up to 7000ft per minute, is equipped with a pneumatic inflatable core, knife changing, hydraulically operated riding roll, while the 80in trim rewinder is of two-drum design and fitted with hydraulically-operated reel lowering arms. Two Gwynne pumps supply fresh water at 60 lb per square inch and the white water is carefully clarified before being returned to the river.

Electricity is taken from an 11kV ring main system and the mill substation houses a 11kV, 500MVA switchboard and a 3·3kV, 150MVA switchboard, provided by the British Thomson-Houston Company, Ltd., and a Crompton Parkinson 415V, 25MVA combined cubicle and Klad Form "A" switchboard. Outside the station are two 7500kVA, 11/3·3kV, transformers and three 1500kVA, 11kV/415V, transformers of Ferranti manufacture. The Harland sectional electric drive for the paper machine is designed for an operating speed range from 500ft to 2000ft per minute and includes twenty-three driving units which take power from a 1300kW generator driven by a 2000 h.p. motor, while, for "starting" and "crawling" the sections, there is an auxiliary generating set. A differential unit automatically controls the speed of each section relative to a master speed reference, while desks near the appropriate section control the section motors. Harland Drives, Ltd., provided the winder drive, which consists of a 275 h.p. motor and a braking generator of 82kW coupled to the unwinding reel, and also the 750 h.p. supercalender motor and the 90 h.p. motor driving the drum of the Pope reel. Direct current is supplied to the main and reel drum motors by a 600kW generator driven by a 875 h.p., 3·3kV, squirrel-cage motor. Ward-Leonard equipment supplied by Printing and Paper Drives, Ltd., powers the 80in rewinder. General mill drive motors below 30 h.p. are of the Crompton Parkinson range and the 3·3kV motors ranging from 180 h.p. to 450 h.p. are of Mather and Platt manufacture. For starting the latter, "Watford" heavy duty direct-in-line air break contactor units are used.

British Standards Institution

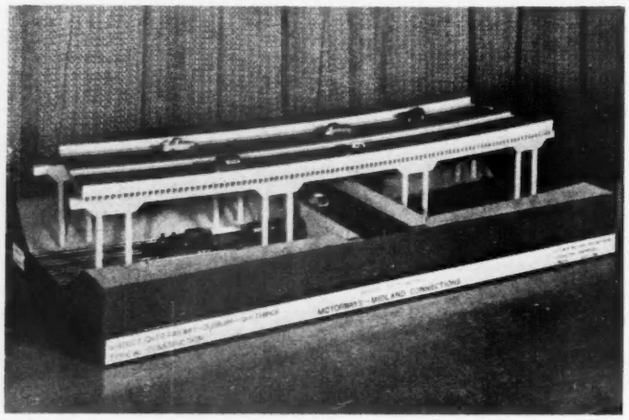
All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

GENERAL RECOMMENDATIONS FOR MANUAL INERT-GAS TUNGSTEN-ARC WELDING—PART 1: WROUGHT ALUMINIUM, ALUMINIUM ALLOYS AND MAGNESIUM ALLOYS

No. 3019, Part 1 : 1958. Price 5s. This British Standard is the first in a series for inert-gas welding. It will be followed by a further part dealing with stainless steel, and subsequently both the light alloys and stainless steels will be covered for inert-gas, consumable-arc welding. The new publication (seventeen pages, illustrated) contains recommendations on the composition and size of filler rods and wires, on equipment, joint preparation, condition of fusion faces, preheating, welding current, electrodes and argon flow rate. Details of the edge preparation required for different thicknesses and for different types of weld are given ; and an appendix provides information on the equipment required.

Progress of the Road Programme

Last week the Minister of Transport and Civil Aviation, Mr. Harold Watkinson, held a press conference at which he reviewed progress of the Government's road plan. Mr. Watkinson's statement is reproduced in abstract hereunder. It includes a proposal for carrying a motorway or viaduct over a railway through an urban region near Birmingham. A model of the viaduct, showing a subsidiary road crossing at a third level, is illustrated on the right.



WHEN the present road programme was launched in 1954–55, there had been little if any major road construction for fifteen years, although the number of motor vehicles in that time had doubled. Our first and most urgent task was to clear the main arteries and create a national network of new or modernised trunk roads. So far we have built, or rebuilt to modern standards, 51 miles of trunk road. We are now building a further 194 miles and starting "forward planning" on 856 miles. These schemes totalling over 1100 miles are in addition to the very large number of schemes, many of considerable magnitude, for which local highway authorities are responsible.

The Government is giving priority to five major projects. Four of these have started and work on the Slough and Maidenhead by-passes which form part of the fifth—an improved road from London to South Wales—should start next spring. I am now able to give you further news of these projects.

The New Great North Road

At the top of the list is our project for doubling the carriageway on the Great North Road between London and Newcastle. Schemes are now being prepared for building dual carriageways along 168 miles. Among them are by-passes at congested areas such as Stevenage, Biggleswade, Stamford, Grantham, Doncaster and Wentbridge, all of which should be started next year. This road before 1955 had dual carriageways for only 18 miles. Since then a further 21 miles of dual carriageway has been added, and work on 27 miles has been started. When these schemes are finished, including those in preparation, all but 35 miles of the route between London and Newcastle will be dual carriageway. The remainder already has a width of 30ft or more and will be "dualled" later.

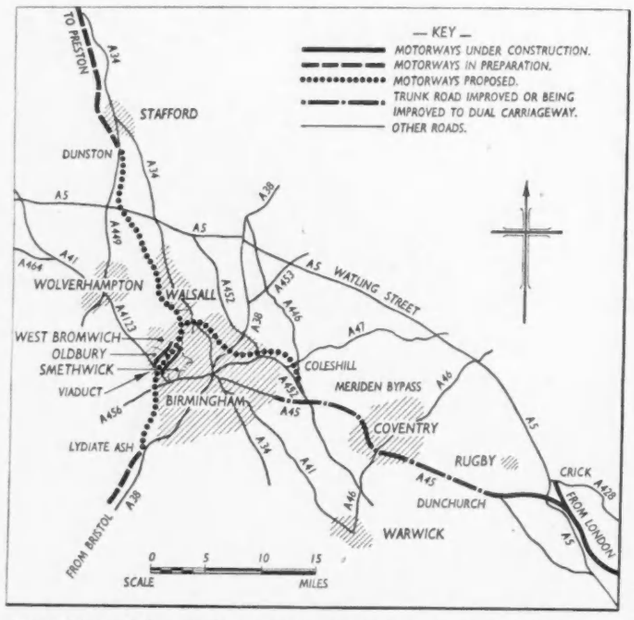
London–Birmingham–Preston Motorways

Preparations are now well advanced for building a motor road, 95 miles long, from Birmingham to the southern end of the Preston by-pass, the 8-mile motorway which the Prime Minister is to open on December 5. It is hoped to start work on viaducts in Staffordshire and Lancashire next spring. Further north, construction of the Lancaster by-pass is going well and a draft scheme fixing the line of the motorway between the Preston and Lancaster by-passes should be published in the coming year. This motorway will form a continuation of the London to Birmingham motorway, which is scheduled to be finished by this time next year. Work is already ahead of schedule.

Improved Roads to the Channel Ports

We are planning to build dual three-lane carriageways all the way along the London–Dover road, A.2, from the Woolwich boundary to the start of the projected Medway motor road. At the other end there will be dual carriageways built between Brenley Corner and Canterbury. When these schemes are finished, motorists will have a dual carriageway road all the way from London to Canterbury. An inner relief road is to be built at Canterbury to take the main road traffic away from the centre of the town.

These plans are part of project No. 3 for improving the existing trunk roads, A.2 and A.20, from London to the south-east coast, by-passing the Medway towns and Maidstone and Ashford. Constructional work on the eastern part of Maidstone by-pass is in progress and work on the second part should follow soon. The line of the 25-mile Medway motor road has been fixed and I hope shortly to publish my proposals for dealing with other roads affected by the scheme.



The Ministry of Transport's proposal for linking the motorways which converge on Birmingham. The proposed viaduct built over a railway is indicated

Midlands to South Wales

Part of this motorway from Upton-on-Severn to Lydiate Ash, south of Birmingham, is in an advanced stage of preparation and it is hoped to start work on it in the next financial year. The next section, 20 miles long, between Upton-on-Severn and Ross-on-Wye, known as the Ross Spur, is being built, as also is the by-pass to Ross itself. From Ross the roads leading to South Wales will be improved, including the Heads of the Valleys Road (A.465) which will be almost completely rebuilt. It is proposed to incorporate in the road parts of the railway line between Merthyr and Abergavenny, recently closed by the British Transport Commission.

London–South Wales Motorway

As already stated, it is hoped to start work in the spring on the Slough and Maidenhead by-passes. This road, 11½ miles long, will form part of project No. 5, a new road leading from London westwards to London Airport, the West of England and South Wales. At the London end of this motorway, as previously announced, it is proposed to build a double-decker road along the line of the existing Great West Road for over 1 mile. I propose to link this road with the Chiswick fly-over so that the fly-over will become part of the high-level road. The necessary modifications in the design of the fly-over are now in hand. At the Welsh end, plans are being completed for the Severn Bridge, the building of which is to be phased with the Forth Bridge.

Midland Motorway Links: Road Above Railway

There is another matter to which we have been giving a good deal of thought. That is how to join the three motorways converging on Birmingham from London and the South-East, South Wales and the West of England, and Preston and the North-West. My consultants, Sir Owen Williams and Partners, have completed their investigation and have recommended a common meeting point just south of Walsall [as shown in the illustration]. The local authorities through whose areas these routes run are about to be invited to meetings at which these proposals will be explained and their views obtained.

We are thinking of building some 3

miles of the connecting link between the motorways from Preston and the North-West and South Wales and the West of England on a viaduct above the railway line through Smethwick and Oldbury and south of West Bromwich. This road over the railway, as well as maintaining the headroom necessary over the railway track itself, would also have to clear existing roads which are bridged over the railway. To do this I am advised that the motorway would have to be at a fairly uniform height of about 45ft above the rail levels.

On the other link with the London–Birmingham Motorway, from south of Walsall, towards Dunchurch, the proposed line would at one point pass within 2½ miles of the centre of Birmingham, greatly facilitating the collection and dispersal of traffic between the motorway and the city. To avoid demolition of property, the consulting engineers have put forward a proposal to culvert the River Tame for about 1¼ miles and carry the motorway along the top of the culvert.

We are also trying to decide on the best line for the second part of the London–Yorkshire Motorway, which, as you may know, has raised many difficulties.

Staines By-Pass

These five major projects—six, if you include the Yorkshire motorway—are only the foundation of a modernised road system. Other overloaded routes are being tackled at the same time and probably one of the worst, from the viewpoint of the private motorist, is the London–Exeter road A.30, through Staines. I hope that work on the Staines by-pass will start early next year. You may form some idea of the complexity of this scheme from the facts that it will be built on embankment for almost its whole length of just over 2 miles, and that it is estimated to cost nearly £2,250,000.

We are also making big improvements on the routes from London to Ipswich (A.12), London to Tilbury (A.13), London to Oxford (A.40), Stafford to Newcastle-under-Lyme (A.34), Lichfield to Derby (A.38), and Derby to Nottingham (A.52).

Traffic Relief Schemes

Another very important part of the programme is concerned with the relief of congestion in large towns. Wherever you go in London you will find work in hand or in preparation—the Cromwell Road extension, the Elephant and Castle roundabout scheme, the New Park Lane scheme and the new Route 11 through the City are obvious examples. Work on the Dartford–Purfleet Tunnel is progressing steadily and planning is well advanced on a second Blackwall Tunnel. The provinces are not being neglected. Planning is going ahead on the Tyne Tunnel, which is expected to cost £12,500,000, and many large towns have started work, or hope to do so in the next year or two, on inner ring roads, relief roads and by-passes, costing in all millions of pounds.

The road works now going on are the outcome of years of unspectacular background work. It takes three or four years and sometimes longer to bring a large trunk road scheme to contract-letting stage. The long preparation is due to statutory procedures, but these are designed to protect the rights of private individuals and cannot be shortened except at the expense of those rights.

The main aim is to produce roads which are adequate throughout their lengths, e.g. the Great North Road and the roads to the Channel ports. At the same time—and this, perhaps, is the most difficult task of all—we must ensure that traffic is not bogged down when it reaches industrial areas. To this end I set up a special committee on London roads under the chairmanship of Mr. Nugent, and I am encouraging the authorities in the largest provincial centres to consider their long term problems in a similar way.

This present volume of work is not just a flash in the pan. The Government is determined to keep up the momentum and schemes are being prepared as far ahead as for 1962–3. We are also making preliminary plans for eight years ahead. In short, the biggest programme the country can afford will be maintained not as a four-year, or even eight-year concept, but as a continuing constructive effort until the country's roads are adequate to its needs.

Pendulum to Atom Exhibition

By T. R. ROBINSON, F.B.H.I.

The horological exhibition "Pendulum to Atom" which was opened in Goldsmith's Hall, London, on October 14, under the auspices of the Worshipful Company of Clockmakers and the British Horological Institute with the collaboration of a number of allied associations, is intended to mark the centenary of the British Horological Institute and to illustrate the developments in high precision time-keeping during the last one hundred years.

THE collection of timekeepers of many different kinds that has been brought together for this exhibition constitutes a remarkable display of what has been called "the art and mystery of clockmaking." Although entitled "Pendulum to Atom," the exhibition is somewhat wider in scope than the title implies, for a number of the examples shown take the history of time measurement back to dates well before the pendulum was introduced. Perhaps a more fitting title would have been "Foliot to Fission." This is very well exemplified by two of the first exhibits seen by visitors as they enter Goldsmith's Hall. One is the wrought-iron, weight-driven clock with foliot balance, originally at Cassiobury Park, and the other the atomic clock, exhibited by the National Physical Laboratory.

The Cassiobury Park clock is typical of the form of timekeeper in general use before the invention of the pendulum. Its frame, which is made up of iron bars, fastened together with wedges, contains two trains of wheels. The timekeeping train is made up of two wheels only, the main and the escape wheel. The escape wheel teeth engage with verge pallets on a vertical spindle, and at the upper end of this is the foliot, consisting of two arms which project from the spindle in diametrically opposite directions and carry small weights near their end. Adjustment of the period of swing is made by altering the position of the weights, but as there is no spring or other device for rendering the action of the foliot isochronous, timekeeping may be very inaccurate and is affected by variations in the driving power and by friction.

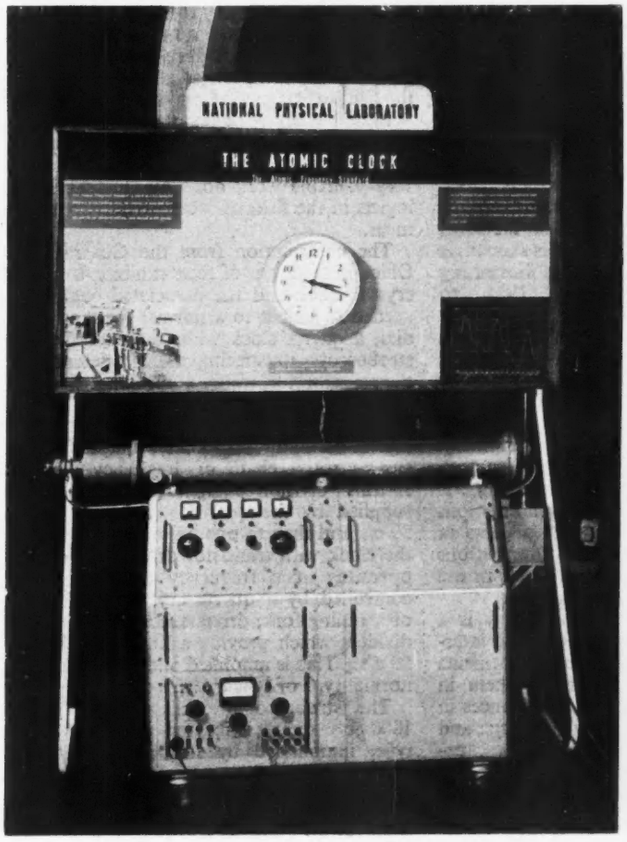


Fig. 1—Arrangement of atomic clock with a superimposed time dial for exhibition purposes

In contrast to the somewhat crude design of the timekeeping part of the clock, the striking part is closely similar in principle to that used to-day. It is of the locking-plate type, and this kind of mechanism seems to have been so well designed by the early clockmakers that it has not been capable of much improvement.

The atomic clock, which can be more correctly described as the atomic frequency standard, is of the kind employed by the National Physical Laboratory to calibrate the standard quartz oscillators. With it, the process only takes a few minutes, as compared with the months necessary to obtain equal precision by astronomical calibration. The atomic frequency standard may be described as the

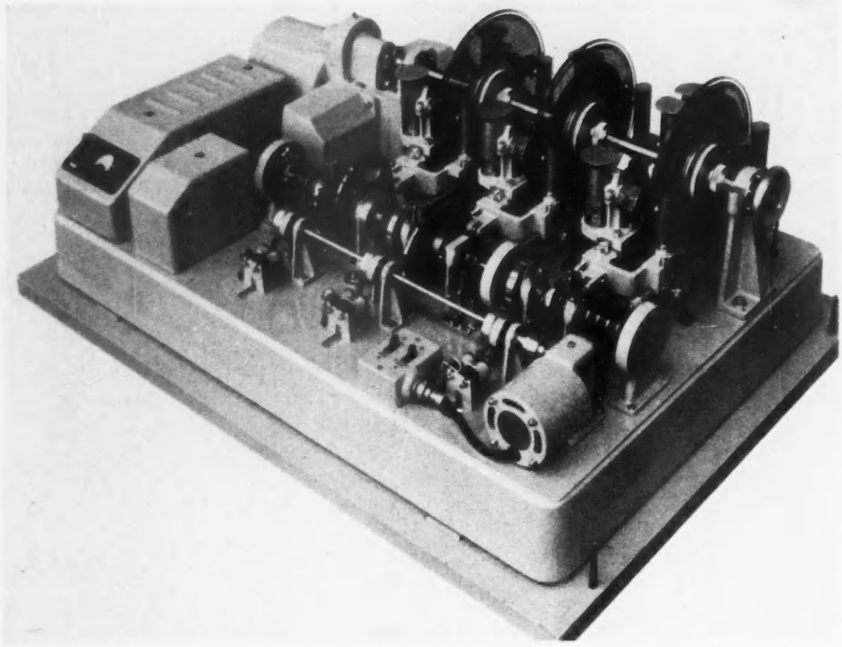


Fig. 2—Post Office Mk. II speaking clock for telephone circuits; time control is by quartz-crystal oscillator

most precise measuring instrument in the world, for it enables frequency and time intervals to be measured with an accuracy of one part in ten thousand million. This is equivalent to one second in three hundred years.

The principle on which the clock is based is that, under certain conditions, the caesium atom absorbs or radiates energy at a definite frequency. This property is extremely stable, and is unaffected by all external influences except that of a magnetic field. The construction of the clock is such that this atomic frequency is used to control an oscillator, which, in turn, can be used for calibrating other oscillators, or to operate a clock dial.

One of the main uses of the atomic clock has been to determine the variations in the rate of rotation of the earth, and on the panel above the clock at the exhibition is shown, as can be seen in Fig. 1, a graph illustrating these variations from June, 1955, to December, 1957.

Not far away from the atomic clock, the B.B.C. shows a "Time in Broadcasting" exhibit, comprising a number of frequency control devices, ranging from early forms of tuning fork drives to the latest crystal controlled drive and its associated equipment. The familiar model of the Westminster clock dials, well known to television viewers, is on view, and there are also photographs demonstrating some of the uses of time in broadcasting, and making comparisons between early installations and those in use at present.

At the head of the main stairway is a number of exhibits, one of the most interesting being a group of models of escapements so arranged that visitors can set them in motion and study their action. Advances in escapement construction from the verge and foliot to the chronometer detent escapement are exemplified by these models, but it seems unfortunate that the gravity escapement, which is probably the most precise of all mechanical escapements, is not represented, for it is very extensively used in tower clocks.

Another interesting display traces the development of the gas controller and time-switch from its early beginnings to the efficient models so widely used to-day. Hand-wound, automatically-wound and synchronous time-switches form part of the group, and the development of the solar-dial, which is used in street lighting to vary the lighting and extinguishing times automatically in step with seasonal changes, is traced from the rather clumsy early forms to the delightfully compact types now employed. A possible glimpse of future developments is given by the inclusion of a time-switch with the Clifford magnetic escapement.

Master clocks, some with free pendulums, made by various amateur experimenters, form another group, and pay tribute to the very valuable work done by amateur horologists in the field of accurate time measurement.

The contribution from the General Post Office is made up of four exhibits, a quartz crystal clock and the associated equipment needed to link it to a normal form of clock dial, a quartz clock with transistor drive, a stroboscope illustrating the movement of a quartz vibrator, and a speaking clock of the type known officially as Mark II. In the quartz clock, a standard Post Office crystal oscillator of 100 kc/s output is used to control a chain of frequency dividers. In this division equipment, the frequency supplied by the quartz is reduced first to 50 c/s and then to one pulse per second. In the clock with transistor drive, an oscillator operating at a frequency of 800 c/s and controlled by a quartz crystal in the form of a tuning fork, drives successive frequency dividers which provide a final frequency of 50 c/s. This is amplified and used to drive a normal type of synchronous clock.

The stroboscopic exhibit consists of a 1000 c/s quartz vibrator of tuning fork type, illuminated by stroboscopic light in such a way that the mode of vibration can be seen. This particular device is most instructive and makes clear to visitors what exactly is meant by a quartz crystal vibrator.

The speaking clock, Fig. 2, shown differs from that used in the British telephone service, in that it is controlled by a quartz crystal oscillator instead of a seconds pendulum. It represents an advance on the older form, and has an accuracy of 1/200th of a second in twenty-four hours. The clock shown is the prototype of two made by the British Post Office for the Australian Post Office and now providing telephone time service in Adelaide and Sydney.

At the opposite end of the stairway hall is a Special Features exhibit, designed to act as a link between the Historical Section and the modern exhibits. Actually, it goes further than this, for it displays many forms of timekeepers, beginning with the earliest—a sundial—shown in pocket form. Pocket sundials were in general use during the sixteenth and seventeenth centuries, and the example shown is a very good specimen. A night dial, a clepsydra, a sinking bowl clock and a sand glass complete the group of very early form of time measuring devices.

A model of Galileo's pendulum clock illustrates the invention which first enabled clocks to become precision timekeepers and so marks one of the most important stages in horological development. Another historic exhibit is the fine specimen of the earliest kind of electric clock, that constructed by Alexander Bain about the year 1840. Very few Bain clocks are known to remain in existence, but that exhibited is in its original condition, and is shown in working order. It is still a fairly good timekeeper.

Moving to more modern developments, the group includes a "Eureka" clock, a rather unusual form employing an electrically impulsed balance wheel. This clock is of special interest for the principle has since been adapted for motor-car dashboard clocks and has recently been reapplied in the mechanism of the electric watch.

One of the main groups in the exhibition, occupying a large room, is the famous "Ilbert Collection" of horological masterpieces. The clock portion of the collection has recently been acquired for the nation and it is hoped that the fine array of watches may also become national property. The collection is so large that it is not possible to mention more than a few outstanding examples. Amongst these is Mudge's first marine chronometer, which won him the British Government award of £3000 in 1792. Other chronometers trace the development of

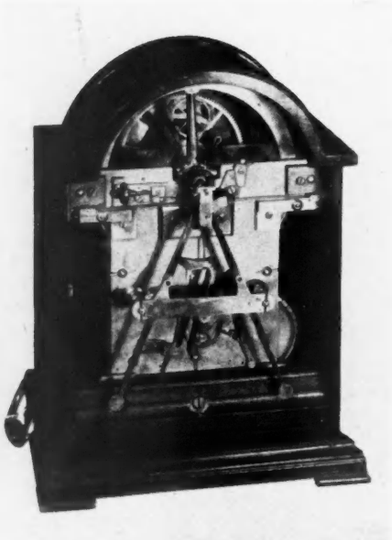


Fig. 3—Bracket clock with lever escapement made by Thomas Mudge, inventor of the lever escapement in 1760

this important form of timekeeper almost to the present day.

A group of period and ornamental watches, displayed not far away, does not seem to illustrate any really important contributions to precise time measurement.

A place of importance is, however, occupied by the lever bracket clock made by Thomas Mudge (Fig. 3), for it is fitted with one of the very earliest lever escapements. Mudge was the inventor of this now almost universally used escapement and this example of a lever escapement of his own construction, still in perfect order, is a focus point for visitors. The lever escapement in the clock does not take the form now generally employed but the important principles which make the escapement so outstanding as a timekeeper are well in evidence. Another Mudge timekeeper shown is a month equation long-case regulator with a perpetual calendar which was the last notable addition to the Ilbert Collection.

One of the other longcase clocks shown in Fig. 4 was a particular favourite with the late Mr. Ilbert. It is a month equation timepiece with calendar, made by the famous George Graham, and fitted with the dead beat escapement and the mercural pendulum, both inventions of the maker. The arch of the dial of this clock is really an elaborate calendar, and from it can be read the day of the month, the equation of time, the time of sunrise, and the declination and position of the sun in the ecliptic or, in other words, the location of the sun in the heavens. Made in 1730, the clock was one of the first " regulator " clocks ever constructed, and so marks an important step in precision timekeeping. Amongst the exhibits of historical interest is a large weight-driven wall clock by N. Vallin, London, which is believed to be the earliest-surviving example of a musical clock. It has separate trains of wheels for chiming the quarters, striking the hours, and chiming on thirteen bells at each quarter. The chime-barrel is fully pierced with thirteen rows of holes, one for each bell, and this enables the rotation of the chime to be altered.

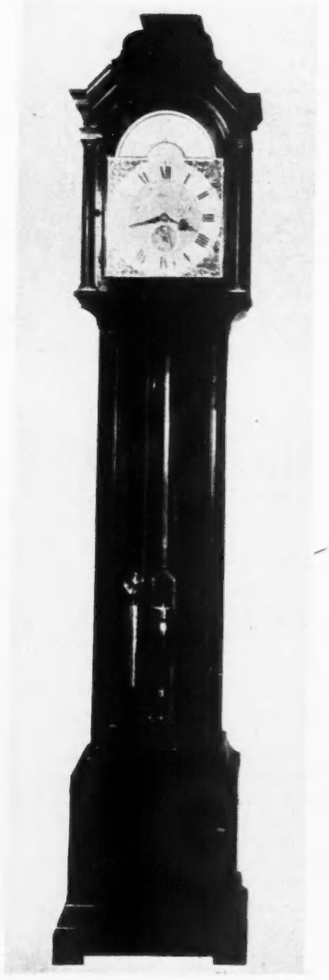


Fig. 4—Regulator clock with dead-beat escapement, mercurial pendulum. Made by George Graham in 1730

The clock is almost entirely constructed of steel, and its escapement has a large and slow-moving balance wheel. Its maker was one of the leading clockmakers of his day.

The modern section of the exhibition comprises a Clock Hall and a Watch Hall, and in these, on a number of individual stands, many of the leading makers of the horological industry display their products. The Synchronome Company of Alperton, Middlesex, shows a complete Shortt Free Pendulum installation, of the kind used as a standard timekeeper in many observatories all over the world. The master and slave clocks are mounted side-by-side and the inter-related action of the two can be followed. There is also a standard master clock and a small circuit of impulse dials, together with a programme ringer which enables bells and other signals to be sounded to any desired schedule throughout a week.

Among marine and house chronometers exhibited by Thomas Mercer, Ltd., of St. Albans, is a very unusual item comprising a normal marine chronometer movement mounted in long rectangular plates and enclosed in a transparent plastic tube so that it can be seen from all angles and the functions of each part studied. This enables the action of the chronometer-detent escapement, usually hidden away between the frames of the normal chronometer, to be studied.

A large tower clock with automatic winding and a double three-legged gravity escapement is the central exhibit on the stand of E. Dent and Co., Ltd., of Pall Mall, London. Beside it is a novelty in the form of a Congreve rolling ball clock. Another tower clock, also with automatic winding, and fitted with a rather unusual single six-legged gravity escapement, is shown by Thwaites and Reed, Ltd., of Clerkenwell. This clock is linked by shafts, universal joints and bevel gearing to a large convex dial at the back of the stand, and illustrates a typical tower clock layout. Another interesting exhibit by the same firm was a means of converting old design hand-wound clocks to automatic winding by an attachment which uses the weight of the winding motor itself to store the necessary power.

A group of time-recorders, illustrating the way in which this industrial timekeeper has developed from the early, and rather crude, types to the compact and versatile models now in use is shown by I.B.M., Ltd. The fact that some of the main improvements have been along the lines of giving better protection against fraudulent recording seems rather a sad reflection on the prevailing standards of honesty.

On the whole, the exhibition is a most informative one, but we feel that it seems to suffer from a certain lack of coherence. The story of the development of precise timekeeping, and of the increasing applications of timekeeping mechanisms to ever-widening fields of use in modern civilisation is a most absorbing one, and deserves to be well told. In some ways this exhibition seems to have missed many opportunities of making this clear. Many of the exhibits do illustrate notable achievements, but there is much more that could be done along these lines, especially in bringing before the public the more specialised applications of horology.

As with previous exhibitions of a similar kind, the " collector's angle " appears to take rather too large a place. The Ilbert Collection is really a group of antique clocks and although interesting from the historical angle it does not tell the story of the ceaseless striving towards better timekeeping, and the gap between the great masters of horology and the developments of our own time seems needlessly large.

Fig. 5—Early musical clock by N. Vallin, which chimes on thirteen bells

Despite these criticisms, however, it must be said that the Pendulum to Atom Exhibition, in promoting the interest of many people in horology, is amply justified, both from the organiser's and the exhibitors' viewpoint.

FLAMMABLE VAPOURS, GASES AND DUSTS IN INDUSTRY.—The most common type of explosion in industry is that which occurs when explosive gases, vapours and dusts are dispersed in air and the Fire Protection Association has produced two technical information sheets on this subject. One, entitled " Flammable Vapours, Gases and Dusts in Industry—Explosions," deals with the general problem, and it stresses the necessity of enclosing where possible processes involving explosive materials so that the gas, vapour or dust cannot escape into the air. Often the possibility of an explosion persists after all practicable steps have been taken to prevent it, and explosion control is necessary. Methods of isolating and segregating the processes in separate housings and flame-trapped compartments, the provision of explosion vents, and the suppression of the explosion between first ignition and attainment of peak pressure by means of a pressure switch are discussed. The other sheet, " Flammable Vapours, Gases and Dusts in Industry—Ventilation," deals with a specific aspect of the prevention of explosion, the use of well-designed ventilation where the liberation of small volumes of gases, vapours and dusts is unavoidable.

The Advanced Gas-Cooled Reactor, A.G.R.

The United Kingdom Atomic Energy Authority has received planning permission to build an advanced gas-cooled reactor (known as the A.G.R. project) at Windscale, Cumberland. This experimental reactor is intended to stimulate further development of the gas-cooled reactor in the direction of higher temperatures and fuel ratings. It will use uranium oxide canned in beryllium and will operate at four or five times the fuel ratings of to-day and at temperatures 200 deg. Cent. above those of Calder Hall. The installation is due to be completed in 1961; it was described in a paper at the recent Geneva conference on The Peaceful Uses of Atomic Energy, from which the following abstracts are taken.*

WITH improvements involving only limited extrapolation, the Calder reactors, fuelled with natural uranium, have developed into a type of nuclear power plant suitable for industrial exploitation. In the United Kingdom, plants now under construction will generate electric power at costs competitive with the coal-fired stations. The economic performance of these plants is more typical of a hydro-electric station than a thermal power station, exhibiting high capital cost and low fuel costs.

It is probable that significant improvements will continue to be made over the next few years in this type of nuclear station within the confines of natural uranium fuel and magnesium cladding material. Development in the pursuit of cheaper electric power, however, must endeavour to make strides into the future. Performance may be improved in three main ways :

(*a*) Higher fuel rating, so that more heat is removed from a given size of plant.

(*b*) Higher fuel operating temperatures, which will assist the attainment of higher fuel rating and enable more of the reactor heat to be converted into electricity.

(*c*) Longer burn-up of the fuel.

A high rating requires a design departure from a simple solid rod to an assembly of thin plates or clusters of small rods so as to increase the rate of heat transfer within the same limits of surface heat flux and central fuel temperature. This fuel geometry inevitably increases the amount of resonance neutron capture of U238 and normally leads to a greater ratio of cladding material volume to fuel volume. It does not seem that any worthwhile thinning or sub-division of the fuel structure is possible while using natural uranium and a graphite moderator, and slight enrichment becomes necessary.

Fuel Cycles for Slightly Enrichfd Reactors

Two fuelling methods are generally considered for these slightly enriched designs, the "once-through" and the "plutonium recycle" systems.

The "Once-Through" System.—In the "once-through" system the fuel is simply replaced by new when it reaches its full irradiation. In equilibrium, the enrichment of replacement fuel may be slightly below that of the initial charge because the whole core will contain more plutonium. Irradiated fuel will contain plutonium and uranium depleted below its initial enrichment. With fuel originally enriched, the recovered uranium may still be of substantial value. Until it is available on a large enough scale to determine its own market, the value of plutonium must be measured in terms of its performance as a reactor fuel and linked to the cost of U235.

Rather more plutonium than U235 must be used for a given yield of neutrons. It is also α-active and so more costly to handle, whether in concentrated form or in a uniform mixture with uranium. Furthermore, the reactivity value of plutonium falls as the higher non-fissile isotopes accumulate with irradiation. Because of these characteristics, the value of plutonium will certainly be less than that of U235, and this has been taken into account in estimating the buy-back value of irradiated fuel discharged from civil power stations.

The "Plutonium Recycling" System.—One use for plutonium is to recycle it in the reactors in which it is produced, so reducing the U235 enrichment required for the replacement charges. In general, this reduction will depend on the fraction of the plutonium recycled, on the initial enrichment and on the nuclear characteristics of the reactor. In the limit, when all the plutonium produced by the reactor is recycled, it is found that for many designs the fuel enrichment required is lower than natural uranium, thus enabling some of the depleted uranium in the rejected fuel to be recycled as well.

For example, in a typical design using oxide fuel elements canned in beryllium, operating to 6000 MWD/tonne burn-up, if all the plutonium is recycled approximately 50 per cent of the rejected uranium can be re-used together with a make-up of 50 per cent natural uranium. This corresponds to a rate of heat extraction from the natural uranium of 12,000 MWD/tonne. Thus, this cycle not only allows a reactor initially requiring enriched uranium to operate on natural uranium feed material but it also achieves a higher effective burn-up of natural uranium than the "once-through" cycle.

The economic comparison of these two cycles for advanced gas-cooled reactors must necessarily wait for more information on the cost of fabricating fuel elements containing plutonium and for more reliable estimates of the market price of plutonium itself.

Use of UO_2 for Long Burn-Up

Whilst present information leads to a confident prediction of a useful life of at least 3000 MWD/tonne with unalloyed metallic uranium fuels under the conditions of the first power stations, it is evident that there is a practical limit set by dimensional instability, especially that due to swelling. It is not certain yet whether the α/β phase boundary is an absolute barrier for unrestrained fuels. Swelling data, in fact, show no pronounced effects; nevertheless it must be assumed that cyclic movement of the phase boundary must have some accelerative effect on the release of gases, in addition to the normal thermal effects.

The present swelling allowances are probably about as much as can be tolerated. This is especially the case in future reactors which are likely to use fuel of more complex design, involving thin sections, small clearances and new heat-transfer surfaces. Some progress will undoubtedly be made on the control of swelling by metallurgical means and by alloying but it would be optimistic to assume that, without heavy alloying, increases in life greater than by a factor of 1·5 to 2, for equivalent swelling can be achieved, especially as there is a strong possibility that swelling may be self-accelerative at high burn-ups. Similarly, the low temperature phenomena of wrinkling and growth may be increasingly difficult to control to such high levels of irradiation.

Thus, a practical target for the development of metallic fuels may be about 4500–6000 MWD/tonne. Above this, say 6000–10,000 MWD/tonne, the ceramic fuels appear more attractive, especially where new cladding materials allow higher surface temperatures than are possible with "Magnox." The general advantages of ceramics are their high melting points, isotropic structure, absence of phase changes and their ability, under appropriate conditions, to withstand high irradiations without external dimensional changes, while at the same time retaining most of the fission-product gases within the lattice. In addition, UO_2 has excellent compatibility with both CO_2 and cladding materials and since its production is simple and its sintering characteristics reasonably well known, it is most suitable for early development.

In common with many ceramic materials, UO_2 has a low thermal conductivity, which decreases with temperature and porosity, and which may further be reduced by irradiation. This leads to large temperature gradients and, in the absence of any real plasticity, cracking generally occurs. In cylindrical specimens this cracking is mainly radial and does not result in overall dimensional changes if the pieces are well supported by the can. The reduction in conductivity on irradiation, however, may be partly due to the continuous formation of cylindrical cracks, which may be self-healing.

For the most economic design, the highest possible rating, not only in terms of heat produced per unit weight of fuel but also in surface heat flux, is desirable. The limit in this direction is related to the maximum centre fuel temperature. At one time the avoidance of melting was regarded as the main criterion. However, it is now known that, owing to the increase in diffusion rates with temperature, appreciable fission-product gas release can take place well below the melting point. The effects of this release depend on the detailed design of the fuel element and the external conditions. Thus, the design of UO_2 elements involves a neat compromise between rating, dimensions, can strength and burn-up. It is difficult to develop this compromise in the usual type of materials testing reactor, since it is almost impossible completely to match the thermal and neutron conditions, on which the results so closely depend, to those of an actual power reactor. Furthermore, it is known that the irradiation characteristics of different samples of sintered UO_2 may vary greatly. The excellence of fit between can and fuel is also important. Sufficient results have been obtained, however, to indicate clearly that with suitable material and design the high burn-up rates are feasible.

* "Advances in the Design of Gas-Cooled Graphite-Moderated Power Reactors," by R. V. Moore, H. Kronberger, L. Grainger.

Development to High Temperature Operation

In the Calder type reactors, the performance of the plant is limited first by the maximum temperature at which the "Magnox" canning may be continuously operated, and secondly by the temperature gradient in the uranium rod. The latter may be reduced for a given heat flux by reducing rod diameter. The former limit can only be removed by the introduction of new cladding materials with higher melting point and better high-temperature properties than "Magnox."

Only three basic alternatives exist: beryllium, zirconium and stainless steel. The first two metals have a low neutron cross-section (for Be, $\sigma=0{\cdot}0011\text{cm}^{-1}$; for Zr, $\sigma=0{\cdot}0076\text{cm}^{-1}$) whilst that for stainless steel is relatively high (for 18/8/1 stainless steel $\sigma=0{\cdot}227\text{cm}^{-1}$). The performance of reactors based on stainless-steel cladding of the fuel elements is very sensitive to the quantities of the stainless steel used. At the present time, both beryllium and zirconium are very expensive. Beryllium is preferred to zirconium mainly because of its lower cross-section and better corrosion resistance to carbon dioxide. However, metallurgically it is little known, and there is little experience in its fabrication. Its use is therefore being preceded by a large-scale development programme.

Successful development of an advanced gas-cooled reactor using uranium-oxide fuel elements clad in beryllium would mean that the capital costs for a given electricity output, would be reduced by at least £20 per kilowatt over a Calder type nuclear power station. In the United Kingdom, where nuclear power is being rapidly exploited, this is an important reduction, since the capital charge is inversely proportional to load factor and the high load factor enjoyed by the early nuclear power stations will not be sustained as an increasing proportion of the nation's electricity requirements is generated from nuclear fuel.

At the present time, the actual saving in unit cost is difficult to assess accurately because the fuel cost is sensitive to such items as cost of fabricated beryllium, the cost of utilising plutonium and so on, which now can only be approximately assessed. However, cautious estimates show that the unit cost from a nuclear power station of the advanced gas-cooled type fuelled with uranium-oxide fuel elements clad in beryllium might well be reduced, at 60 per cent load factor, by 20–25 per cent compared with what can be achieved from Calder type stations using the present natural uranium metal fuel elements clad in "Magnox."

Other Problems of the Advanced Gas-Cooled Reactor

A new fuel to operate at high temperature, high rating and sustain a long burn-up without an excessive number of failures in service is not the only problem involved in the development of advanced gas-cooled reactors. The moderator must withstand the more severe conditions of radiation and temperature, new control problems arise, while the utilisation of plutonium fuel in the proposed plutonium-equilibrium cycle introduces both metallurgical and control problems.

Stored Energy in Graphite.—The damage caused in graphite by neutron bombardment is generally assumed to involve two processes —movement of atoms from the lattice to interstitial sites, and the migration of interstitial atoms to vacant sites, or to form interstitial aggregates (or "complexes"). Potential energy is stored in the graphite as a result of the formation of interstitial atoms and when the latter subsequently form complexes this energy is partially annealed. The amount of energy stored, apart from depending on the irradiation dose, is critically influenced by the temperature at which irradiation is carried out. As this temperature increases, interstitial atoms become more mobile so that there is a greater probability of them returning to a vacant site or forming a complex, and the net rate of energy storage falls.

At temperatures of 250 deg. Cent., or higher, radiation annealing occurs, and it is believed that complexes are broken up by neutron bombardment. With increasing radiation doses, the energy stored in the form of complexes at interstitial sites probably reaches equilibrium since there is a greater probability of broken-up complexes returning to lattice sites with release of their stored energy, as the number of lattice vacancies increases. Consequently, there is a reasonable expectation that the graphite in advanced gas-cooled reactors operating at gas temperatures of 250 deg. Cent. or above will store comparatively small quantities of energy during their operating life. This has not yet been confirmed experimentally although, ignoring the possibility of attaining equilibrium, extrapolation of existing data suggests that after a radiation dose equivalent to twenty years' operation at a thermal flux level in the fuel of 5×10^{13} neutrons per square centimetre second, a graphite moderator at 250 deg. Cent. contains only about 10 per cent of the energy of a graphite moderator subjected to the same dose at 200 deg. Cent.

Chemical Reaction Between Carbon Dioxide and Graphite.†—The precise mechanism of chemical reaction between carbon dioxide and graphite when activated by radiation has not been so far established, but it is believed to involve the formation of short-lived ions. The species CO_2+ and $CO+$ have been identified as a result of preliminary experimental work. There is no evidence that the reaction rate is influenced by changes in operating temperature below 500 deg. Cent., but it appears to be proportional to gas pressure and gamma flux intensity.

In reactors of the Calder Hall type, the rate of oxidation of graphite is acceptably low, being of the order of 0·05 per cent per annum by weight. In more advanced gas-cooled reactors increases in gamma flux consequent on the higher fuel ratings may make reaction rates between carbon dioxide and graphite more significant. Methods of controlling the reaction depend on the prevention of the short-lived active species from reaching the graphite, either by removing them or by isolating the graphite. At least four possibilities exist:

(*a*) Provision of an impervious barrier between the gas and the graphite in the form of metal cladding; for high-temperature reactors, suitable metals are stainless steel (which would call for an increase in fuel enrichment) and beryllium.

(*b*) Deposition of an impervious coating on the graphite surface, for which the bonding process is a major problem.

(*c*) Removal of the active species in the gas phase by the introduction of an inhibitor.

(*d*) Introduction of replaceable graphite sleeves into the reactor channels. This can be fully effective only if the reaction is predominantly confined to the graphite surface.

† Anderson, A. R., *et al.*, "Chemical Studies of Carbon Dioxide and Graphite Under Reactor Conditions," Second United Nations International Conference on the Peaceful Uses of Atomic Energy, Geneva, 1958.

If deposition of carbon in the external circuit (e.g. on the heat-exchanger surfaces) proves troublesome it could probably be controlled by continuously reconverting the carbon monoxide produced in the reactor to carbon dioxide in a small flow by-pass system. This plant addition would not add substantially to capital or running costs.

Neutron Flux Instability.—In any reactor a change in local reactivity will produce a flux change of the same sign after a small delay. If, by any means, such a flux change can itself result in a local change in reactivity of the same sign the situation is potentially unstable. Such means are provided by the "xenon hump" effect, which has a time constant of some hours, or by a positive moderator temperature coefficient which has a time constant of some minutes. The two effects can interact. If the effect is controlled by xenon, it may manifest itself as a slow oscillatory divergence, since eventually the increased rate of production of xenon by decay of iodine may exceed the rate of destruction. The pure temperature effect is non-oscillatory.

When the disturbance covers the entire reactor, control may be exerted at any point, so that such instability in the fundamental mode can readily be controlled in normal operation. It may be, however, that the stabilising effect of leakage from one zone of the reactor to another is not sufficient to prevent the setting up of unstable modes in which the flux shape departs from the fundamental and nodal surfaces exist. Such instabilities call for special control arrangements. Existing reactors in the U.K. display instability in the fundamental mode only, but larger and more highly rated reactors may display instability in some of the higher modes as well and they will have to be provided with suitable control systems. Such instability does not, of course, constitute a danger, since its occurrence is associated only with operation at power and can be brought to an end, if need be, by shut-down.

Metallurgical Problems with Plutonium Fuels.—Plutonium cannot be used in the pure metallic state since its low melting point (640 deg. Cent.) and its allotropic changes would lead to severe distortions on temperature cycling. Uranium alloys with plutonium are not expected to withstand high burn-up without distortion. Many plutonium alloys with metals of low cross section have low melting points and would possibly melt or collapse under temperature transients. However, consideration is being given to the possibilities of alloying plutonium with iron, beryllium or zirconium.

As the advanced gas-cooled reactors will probably use uranium oxide as fuel, interest is concentrated mainly on recycling the plutonium in the form PuO_2 or Pu_2O_3. If the plutonium is to be distributed uniformly in the fuel then UO_2+PuO_2 is the obvious choice and it is estimated that the cost of fabricating this fuel would be less than that of a uranium-plutonium alloy. If the plutonium is to be recycled in "spike" form then the diluent used must have good thermal conductivity under irradiation unless very thin elements are possible. A PuO_2+Fe cermet is expected to be cheap to produce and to have stability at elevated temperatures and the same is true for a "spiked" element made from graphite and Pu_2O_3. Other possibilities are $BeO+PuO_2$ and ThO_2+PuO_2 as well as mixtures of carbides.

Development work is being undertaken on the problem of determining the best method of recycling plutonium in these reactors, and it is expected that the problems of alpha-active fabrication and radiation stability

will be overcome at a price which will make plutonium recycling economic.

The Advanced Gas-Cooled Reactor

From the above discussion, it can be seen that although the direction for development of the gas-cooled graphite-moderated reactor is clear, there are a number of technological problems to be overcome and no doubt others will reveal themselves as development proceeds. Accordingly, to stimulate and focus this work and to provide adequate testing and proving facilities, the U.K. Atomic Energy Authority is proceeding with the design and construction of an experimental advanced gas-cooled reactor (the A.G.R. project). The plant will be completed early in 1961.

The A.G.R. is designed to operate at a high temperature and high fuel rating. The primary fuel is uranium oxide clad in beryllium and the flexibility of the plant is such that, whilst only the first charge has been specified, later charges either radically different or of more advanced design can be readily accommodated.

The choice of size for the A.G.R. was governed by the necessity for providing sufficient channels for statistical proof of the performance of fuel elements and also to provide a number of channels of substantially higher rating than is expected in the large civil power stations based on A.G.R. technology, so as to give a lead on performance. An unflattened core gives a wide range of neutron flux so that with an average fuel rating of 8MW per tonne (U), there is an outer region of the core having a large number of channels with flux levels spanning those forecast for the large civil power stations, together with a central zone of higher rating having a peak value of 18MW per tonne (U). The final choice was a core with 250 channels, giving a total heat output from the core of 100MW. The following table gives a selection of the more important parameters, performance and design data.

Table—*Main Parameters, Performance and Design Data of the A.G.R.*

Reactor heat rate	100MW
Net electrical output	28MW (E) approximately
Reactor core :	
Core length (excluding reflector)	14ft
Core diameter (excluding reflector)	15ft
Total number of channels	250
Gas pressure at reactor inlet	270 lb per square inch gauge
Gas temperature at reactor inlet	250 deg. Cent., rising to 325 deg. Cent.
Bulk gas outlet temperature	500 deg. Cent., rising to 575 deg. Cent.
Normal maximum fuel element can surface temperature	600 deg. Cent.
Fuel and physics data :	
Total weight of UO_2 fuel in core	14·6 tonnes
Mean reactor rating	7·75MW per tonne (U)
Peak reactor rating	18·00MW per tonne (U)
Initial enrichment	1·65 C_5 (approximately)
Average thermal flux	$1{\cdot}49 \times 10^{13}$n per square centimetre second
Peak thermal flux	$3{\cdot}45 \times 10^{13}$n per square centimetre second
Control :	
Number of control rods	25
Total reactivity absorbed	14 per cent approximately
Engineering data:	
Cylindrical pressure vessel, internal diameter	21ft
Cylindrical pressure vessel, overall height	60ft approximately
Weight of moderator, including reflectors	200 tons approximately
Number of external circuits	4
Number of main circulators	4
Power of circulator coupling	1200 h.p. approximately
Charge and discharge of fuel	On load
Steam cycle	Single pressure
Superheater outlet pressure	620–670 lb per square inch gauge
Superheater outlet temperature	860 deg. Fah. (460 deg. Cent.)
Dump condenser rating	100MW

Development during the life of the reactor itself is to be expected and a substantial increase in fuel rating can be achieved, at constant power output, by reducing the number of channels loaded with fuel elements and in increasing the enrichment, the surplus channels being blanked off with graphite plugs. The heat exchangers and main gas circulators have the necessary flexibility incorporated in their design to enable this change to take place without the necessity for major modifications.

Each fuel channel is connected directly to its own branch in the pressure vessel head at the top of the reactor, giving individual access to each channel, which is then fully equipped with instrumentation and fitted with its own flow control. Refuelling can be carried out at full operating gas pressure and while the reactor is on load. Provision is also made for tubes to be passed right through the core, isolating a channel from the rest of the reactor for special loop experiments, such as continued irradiation of fuel elements after failure in order to study their behaviour.

The graphite moderator is also replaceable on a reconstruction basis, a shield being provided inside the reactor pressure vessel immediately above the core, enabling full access to the head of the vessel for its removal and subsequent replacement after the graphite core reconstruction. This facility will enable the graphite core to be replaced, if its life for any reason is limited, either by one of the same, or one of improved, specification.

The general layout of the reactor unit is such that the fuel channels are vertical and the gas flow upwards through the core. The core, complete with its restraint gear and internal thermal shield, is contained within a vessel 21ft in diameter and about 60ft in overall height. Refuelling and control are from the top face. Branches are provided in the bottom head of the vessel, giving straight-through access and enabling test loops to be incorporated. The reactor vessel is of double-shell construction. Carbon dioxide at the inlet temperature of 250 deg. Cent. (maximum inlet 325 deg. Cent.) sweeps the gap between inner and outer shells, keeping the main wall of the pressure vessel at the lower gas temperature.

The external circuit consists of four parallel limbs, each consisting of a heat exchanger and main circulator. The heat exchangers are raised in relation to the reactor itself in order to promote natural circulation of the coolant in the event of main circulator failure. Since the plant is purely experimental, a single pressure steam cycle is used with the modest steam conditions of 600 lb per square inch, 850 deg. Fah., at the turbine stop valve. A higher efficiency could be achieved with a more complex steam cycle which will undoubtedly be used in the civil power stations eventually designed on the basis of A.G.R. technology. A single turbine is used, coupled with dump condenser facilities capable of rejecting the full heat output of the plant to force-draught cooling towers. The main circulators are electrically driven through fluid couplings, giving a 4 : 1 speed range.

The safety problems of the reactor are similar to those of existing reactors in that the fuel elements are designed to retain the fission products ; the reactor operates with a clean coolant and is equipped to detect and locate faulty fuel elements. In view of the experimental nature of the reactor it has been decided to design for full containment. The reactor unit is therefore enclosed in a steel container building which will accept the total contents of the CO_2 gas circuit.

Conclusions

As this new (A.G.R.) technology develops, it will be incorporated in the design of the civil power stations, reducing their capital cost per kilowatt. This will enable nuclear power stations to remain economic with the falling load factor which is bound to occur as nuclear fuels supply an increasing percentage of the country's power requirements. It is also anticipated that fuel costs will be reduced from the effect of higher plant efficiency, higher fuel rating and longer burn-up. It is probable, therefore, that, except at very low load factors, the total cost of power from nuclear stations in the United Kingdom coming into commission from 1965, will fall below that of power generated by conventional plant. Given the success expected with what may be described as "A.G.R." technology, it is thought that in the United Kingdom the CO_2-cooled graphite-moderated reactor will remain highly competitive with other forms of nuclear power plant for at least the next decade.

Effluents from Winfrith Heath Atomic Research Station

In a paper presented at a sessional meeting of the Royal Society for the Promotion of Health, in Dorchester on October 10, Mr. L. Abbott, county planning officer, Dorset, discussed the anticipated impact of the Winfrith Heath Atomic Energy Research Establishment on Dorset. The following short abstracts from the paper deal with discharge of radioactive waste into the sea.

The project occupies 688 acres of a 900-acre bare heathland, situated 8 miles from Dorchester, 7 miles from Wareham and 4 miles from the sea. Apart from the village of Wool (1250 population), 1 mile from the eastern end of the site, and the Royal Armoured Corps Headquarters at Bovington Camp, 2 miles to the north-east, the area is sparsely populated.

The Minister of Housing and Local Government informed the County Council, in March of this year, that he had received an application from the U.K. Atomic Energy Authority for an authorisation in respect of a total discharge not exceeding 2500 curies of radioactive effluent in any one calendar month, to be conveyed by a pipeline crossing the coast at Arish Mell and extending 2 miles out into the sea. Within this limit, specific limits on discharges of particular radioactive elements in any one calendar month were not more than 750 curies of ruthenium-106 ; not more than 100 curies of strontium-90, and not more than 100 curies of total alpha activity. The Ministry went on to state that as a result of extensive tests carried out by the Authority, with the assistance of the Admiralty, into the likely dispersal of the effluent, it had been found that the tides and currents at the point of discharge would produce considerable dispersion ; it appeared, therefore, that the application could be authorised with safety. The use of the sea and beaches for bathing and other recreational activities was taken into account in reaching this conclusion.

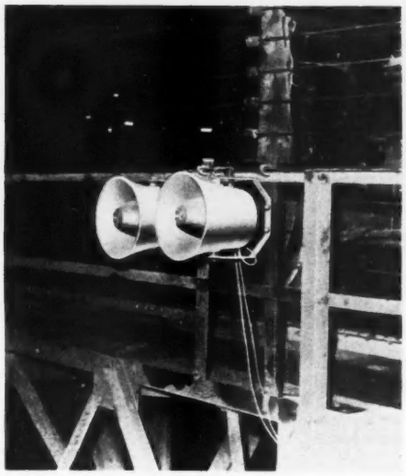
The County Council raised no objection to the proposals, subject to the following requirements : that assurances be given that all radioactivity arising from the effluent within the pipeline will be effectively sealed off throughout its length, particularly where it passes under the beach ; that assurance be given that the discharge of effluent with an activity of 2500 curies in any one calendar month will be carried out at an even rate so as to ensure that the radioactivity remains constant from day to day ; that any increase in the radioactivity in the effluent of 2500 curies per calendar month be a matter for further consultation with the County Council ; that an area of water in the vicinity of the outfall of the effluent from the pipeline be permanently buoyed, this area being sufficiently large so as to prevent persons entering a zone where they would run the risk of being exposed to a radiation of dangerous intensity. Two further requirements were that regular samples be taken and tests made at such places and of such nature and frequency as shall be determined in agreement with the County Council to ascertain the degree of radioactivity present from time to time on the beaches of the county and the adjoining coastal waters ; and that the County Medical Officer of Health be supplied with copies of all reports on tests and samples taken in connection with the discharge of radioactive effluent.

SHORTER REPORTS

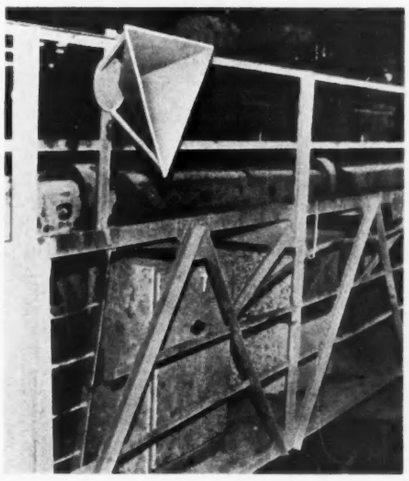
Crane-Approach Warning System

In factories and steel works where two or more overhead travelling cranes operate on the same track there is constant danger of collision, because the crane driver must concentrate on his load and the signals of his slinger rather than on the movement of neighbouring cranes. To eliminate this danger and so promote greater safety in industry, a new electronic equipment has been developed, under the auspices of the British Iron and Steel Federation, by the British Thomson-Houston Company, Ltd., and an installation has been undergoing extensive trials at the Redbourn, Scunthorpe, iron and steel works of Richard Thomas and Baldwins, Ltd.

Fundamentally, the B.T.H. system is based on the principle of the echo sounder. An oscillator circuit generates short electrical pulses at regular intervals which are emitted in the form of very-high-frequency sound (just above the threshold of the human ear) by a loudspeaker fitted on the crane, as illustrated here. The sound pulses are reflected by a special trihedral reflector fitted on the neighbouring crane and the echo is picked up by a microphone mounted alongside the sound source. The microphone signal is then amplified and fed to relays which may operate audible alarm or visual indicating circuits in the driver's cab, or may be used to initiate automatic braking of the crane. Automatic warning of approach can thus be given to one or more cranes operating on the same track, or to cranes operating at different levels.



Loudspeaker and microphone pick-up in re-entrant horns mounted on one of two cranes running on the same track



Trihedral reflector mounted on travelling crane to reflect signal pulses emitted from loudspeaker on the other crane running on the same track

A characteristic of this warning system is that the protection it affords can be made effective at any desired position on the crane track merely by placing a trihedral reflector in the path of the sonic beam. Over-running at end stops can thus be avoided and complete protection can be given to maintenance men working on a disabled crane, or on the crane track.

The warning equipment can be adjusted to operate up to a distance of 60ft from the reflector; longer distances may be accommodated later. The oscillating frequency is 11 kc/s and the time taken for a return echo to operate the protective system is 2 milliseconds per foot. Selective circuits are designed to make the alarm system unresponsive to any other signals than those of the genuine echo. The system is designed to operate from any d.c. crane supply, but where cranes operate on a.c. suitable rectifiers may be supplied for conversion.

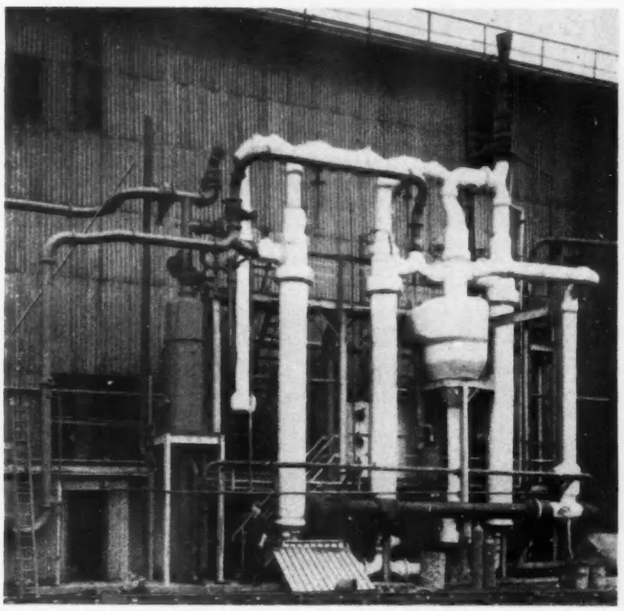
We learn that the installation of B.T.H. sonic equipment at Redbourn has proved successful in service, and it has withstood the prevailing conditions of heat, vibration and dust without failure. Equipment of this kind is now recommended in the booklet, "Crane Safety in the Iron and Steel Industry," recently published by the British Iron and Steel Federation.

Combined Desulphurising and Sulphuric Acid Plant

As a result of ten years of experiments and pilot plant trials, the Appleby-Frodingham Steel Company, a branch of the United Steel Companies, Ltd., has developed a new combined desulphurising and sulphuric acid plant. The first full-scale plant to this design is being installed at Appleby-Frodingham and is due for completion by mid-1959.

In issuing particulars of the plant, the firm points out that at most integrated steel works, a certain proportion of coke oven gas is used to fire the open-hearth melting furnaces, the remainder being used in reheating furnaces and soaking pits. This gas contains about 1 per cent of sulphur which, apart from adding to the difficulties of making low sulphur steel, results in considerable quantities of sulphur dioxide being released into the atmosphere. In an integrated works making 1,000,000 tons of steel ingots a year, it is stated that the use of the new process will enable the sulphur dioxide to be recovered, and from it as much as 250 tons of sulphuric acid could be produced weekly.

The plant consists essentially of a fluidised hot iron oxide absorber and regenerator, and is capable of removing both hydrogen sulphide and organic sulphur to very low levels. At the same time it enables the recovery of considerable quantities of sulphuric acid. The heat requirements of the plant are met by the combustion of the absorbed sulphur and, once started up, it is self-sustaining for heat.



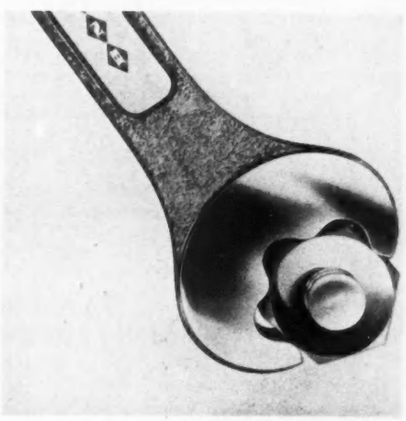
Pilot desulphurisation and sulphuric acid plant capable of purifying up to 3,000,000 cubic feet of coke oven gas per day

The pilot plant which has been in successful operation for two years, purifying up to 3,000,000 cubic feet of coke oven gas per day, is illustrated above. The full-scale plant, when completed, will deal with 32,000,000 cubic feet of gas per day.

Multi-Face Gripping Spanner

We illustrate below a new design of spanner made in the usual range of sizes by Brades Nash-Tyzac, Ltd., Oldbury, Birmingham. These spanners are so made that their jaws are given a positive grip on the centres of four of the flat faces of a hexagon nut or bolt head.

With this design the pressure imparted when turning nuts or bolts is taken on four of the faces and set on the corners, and the jaw opening of the spanner is automatically centred. The spanner can be used effectively when unlocking or tightening nuts which have had their corners rounded in service or by other tools.

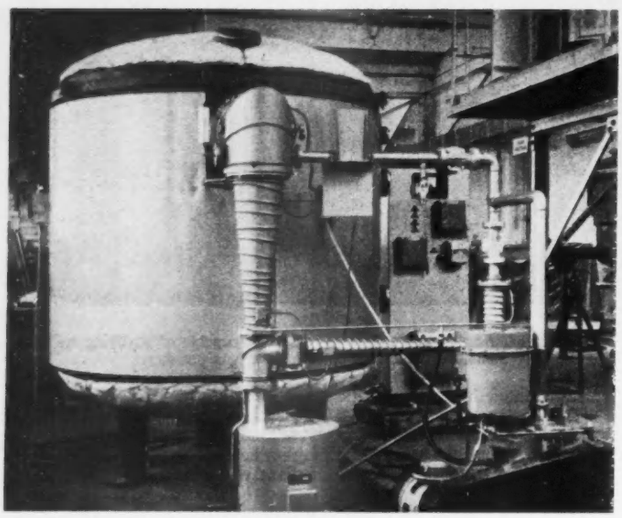


Fixed jaw spanner which exerts its grip on four flat faces of a nut

Vacuum Drying

VAPOUR booster pumps made by Edwards High Vacuum, Ltd., Crawley, Sussex, have proved suitable for the drying and impregnation of electrical components. For certain types of electrical assemblies it is advantageous to employ comparatively high vacuum where possible and the firm has recently completed a small self-contained plant. This equipment is being used for processing of experimental insulation assemblies and the investigation of vacuum drying and insulation at pressures of 0·1mm Hg and below.

The plant, shown in the illustration below, consists of a processing chamber 6ft in diameter and 8ft high, standing on three supports. The chamber has a detachable flanged lid complete with observation ports, and blanked off ports are also provided in the body of the tank so that, if required, dry air circulation and oil admittance can be used. The chamber carries a 12in flange fitted with "Speedivac" electrodes so that electrical measurement can be carried out on the components in the chamber during the actual drying process. The main body of the tank is covered by a thermostatically controlled electric blanket, in this case to provide a temperature up to approximately 110 deg. Cent., and both the bottom of the tank and the lid are lagged.



Self-contained drying and impregnation plant for processing experimental insulation assemblies

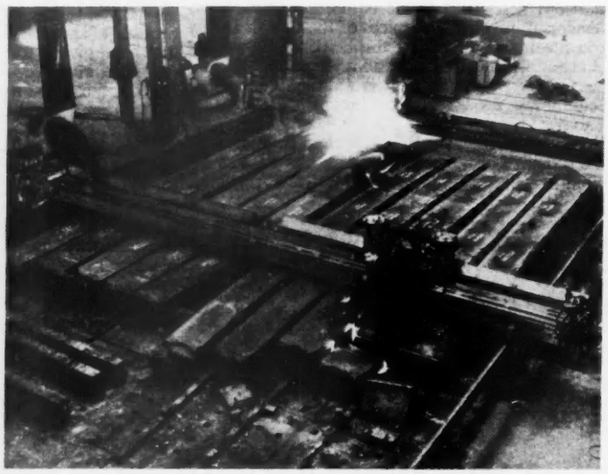
The "Speedivac" vapour booster pump backed by a 100 cubic feet per minute rotary pump provides the pumping equipment, the booster being connected to the tank by a right angle baffle and isolation valve. The pumping lines are complete with manually-operated diaphragm type valves. Vacuum measurement in the rotary pump backing line is by an enclosed industrial gauge with a 1·0-0·001mm Hg range while the vacuum above the booster pump is measured by a Pirani gauge head. The power unit is mounted in a separate control cabinet which also includes the control switches and indicator lamps for the diffusion pump, electric blanket and other equipment.

This particular pumping system is stated to be capable of reducing the pressure in the unloaded tank to 1 micron in ten to twelve minutes. The makers point out that the pumping system, gauges and valves can be altered to suit individual requirements.

Stainless Steel Slab Cutting Machine

A SPECIAL oxygen cutting machine made by Hancock and Co. (Engineers), Ltd., Croydon, Surrey, has been installed in the Park Works of the English Steel Corporation, Ltd., for cutting large stainless steel slabs. This machine uses the oxygen/powder cutting process whereby a finely divided iron powder, which can also contain a proportion of magnesium or aluminium, is fed into the normal oxy-acetylene flame. In this process the powder is introduced into the flame because for cutting stainless or high alloy steels a normal flame, as used with conventional carbon and low alloy steels, is not suitable owing to the fact that the oxides of high alloy steels are refractory and have melting points higher than the parent metal. In powder cutting the powder burns to release large volumes of additional heat and has in effect a fluxing action which overcomes the effect of refractory oxides and produces good quality cuts.

The machine, which can be seen in operation in our illustration, is designed to cut slabs up to 6in thick and weighing up to 12 tons. It has a cutting area of 27ft by 42ft and its main gantry rails are 60ft long. These rails carry two gantries each spanning a width of 30ft to give the cutting width of 27ft.



Trimming cuts being made on oxygen/powder flame cutting machine for stainless steel slabs

A heavy duty driven carriage on each gantry carries a pair of iron powder dispensers and two burners mounted on an outrigger on which they can be set to make cuts up to 48in apart. Each gantry is also equipped with an additional independent non-driven carriage, carrying a single burner. Services to each driven carriage include oxygen, acetylene, compressed air lines and electric power cable. These lines are carried in a stainless steel spiral which lies in channels affixed to the side of each gantry and alongside the main rails, coiling and uncoiling smoothly as the traversing motions take place. A cradle on the driven end of each gantry carries air driers for the powder dispensers, each dispenser having a pair of driers. Whilst one drier of each pair is in operation the other is being reactivated, humidity indicators being fitted to show by colour change when it is necessary to switch over from one to the other drier. The powder cutting attachment fitted on each of the burners consists simply of a small diameter tube, and during cutting this powder dispensing tube precedes the burner.

The slabs are generally lined up for cutting parallel with the main rails of the machine and all cutting is made in the transverse direction as the long sides of the slabs do not normally require trimming. In the sequence of operations one of the gantries is brought into position over the "ingot head" end and the driven carriage is then traversed, making two trimming cuts about 20in apart, whilst the other gantry is used to remove the "bottoms," all cuts being made simultaneously. This operation is shown in the illustration. When taking the two trimming cuts the burner nearest the end of the slabs leads slightly to ensure that it completes its cuts before the other burner. Trimming procedure is continued until sound metal free from ingot head faults is reached and the slabs are then cut into lengths of approximately 6ft.

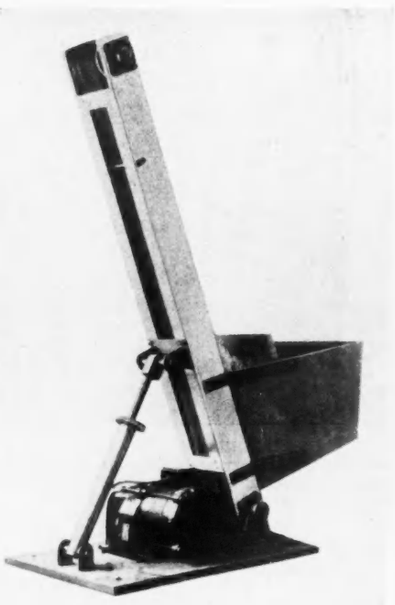
It is stated that over a three-month period this machine dealt with about 6000 tons of stainless steel slabs. Reckoning on about 30ft of cutting for each slab this total represents some 15,000ft of cutting.

During this period the single tube powder cutting attachment proved completely effective and trouble free, whilst significant economies in iron powder consumption were achieved.

Magnetic Conveyors and Elevators

THE photograph we reproduce below shows a design of magnetic belt conveyor or elevator now being made by Rapid Magnetic Machines, Ltd., Lombard Street, Birmingham, 12, for the transportation of steel components. In this design, unlike the conventional conveyor, the angle of inclination is not of critical importance, and the unit can be operated at any angle from the horizontal to the vertical position and, in some instances, is arranged to lift vertically prior to transporting horizontally.

Either side of the conveyor can be arranged as the operational surface, enabling components to either be carried in the customary manner or suspended from the underside. It allows the pick-up and transfer of lightweight metal components from one conveyor or process to another.

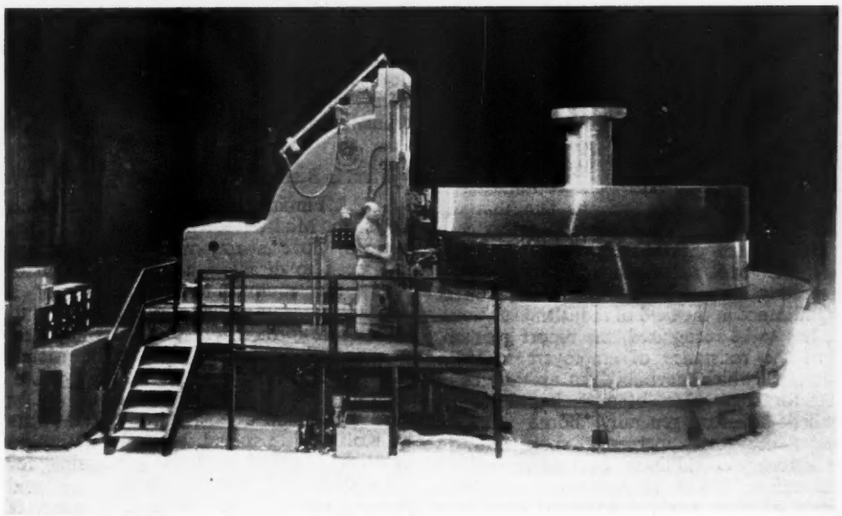


Magnetic belt conveyor or elevator for handling steel components

The equipment is self-contained, portable types being available, and it is produced in several belt widths, whilst the angle of inclination and overall height can be arranged to individual requirements.

Large Vertical Gear Shaving Machine

SOME notes have been received from Gaston E. Marbaix, Ltd., Devonshire House, Vicarage Crescent, London, S.W.11, on the very large gear shaving machine made by the Michigan Tool Company, of the United States, which is shown in the illustration below. This machine is designed to finish gears from 80in to 200in diameter with face widths of up to 74in. The work table, capable of supporting workpieces of 150,000 lb with a 50,000 lb fixture, is stated to rotate within 0·0002in of concentricity and to be accurate within 0·0002in of run-out in the flat plane of rotation. The machine was specially designed and built for shaving marine turbine reduction gears at the West Lynn works of The General Electric Company. It shaves internal or external spur, helical or double-helical gears, with or without integral shafts up to 40½in diameter.



Shaving machine for gears from 80in to 200in diameter

The machine has dual cutter heads which are independently adjustable for angle, and the upper head is adjustable for height. The cutters used can, if required, have a wide groove in the centre to provide two shaving zones on each gear—one zone serving to steady and guide the other. Cutters from 7in to 12in diameter and up to 3in wide can be used on the machine.

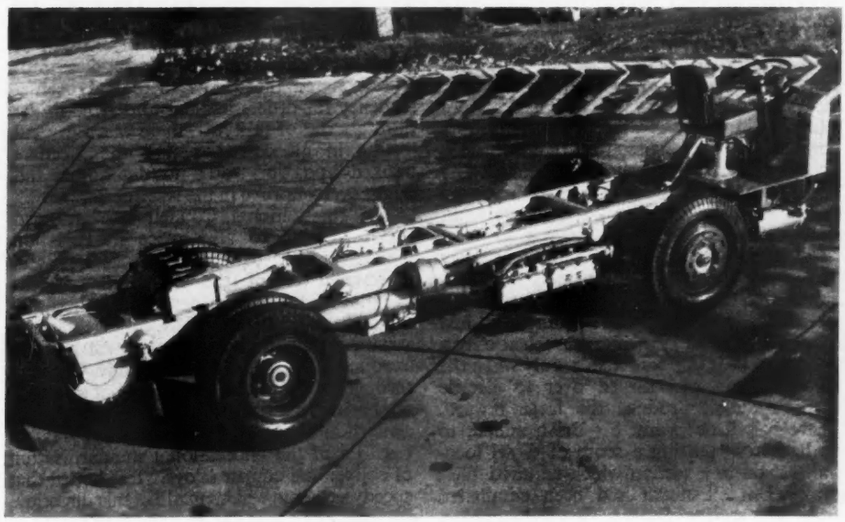
The table is carried by a film of oil under pressure during the shaving operation and is driven by a variable speed motor at from 0·93 to 15·16 r.p.m.

Fire Appliance Chassis

THE manufacture of chassis for fire-fighting appliances has been resumed by Leyland Motors, Ltd., after an interval extending back to before the last war, with the introduction of the "Firemaster," of which the first example has been produced for Manchester City Fire Brigade. The chassis has a basic resemblance to a "Worldmaster" p.s.v. chassis and uses the 0/600 oil engine with a rating of 150 h.p. at 2200 r.p.m. The "Pneumocyclic" transmission drives to a Leyland axle to which an Eaton two-speed final drive can be fitted. The radiator, as can be seen, is on the near side of the vehicle forward of the rear wheels: the right-angle drive for the fan is driven by belts from pulleys behind the fluid coupling, so that it is imperative that the transmission be in neutral when pumping: the pneumatically-operated dog clutches engaging the pump drives are therefore interlocked with the gear selector.

The pump drive is taken from the front of the engine to main and first aid pumps. The engine is governed at 1500 r.p.m., a pump speed of 3000 r.p.m., when pumping, and the main pump can be up to 1000 g.p.m. Suction and output branches and the pumping controls are in front of the vehicle.

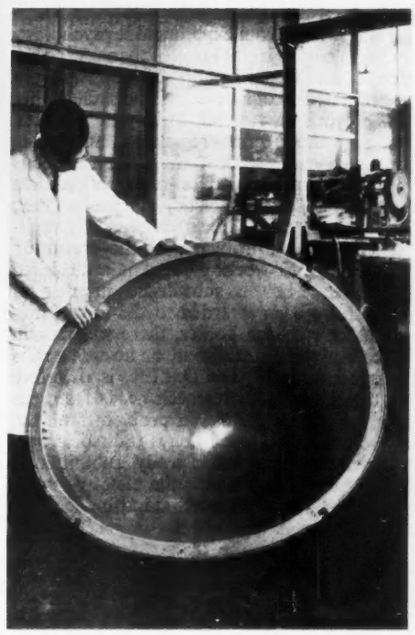
It is claimed that the underfloor engine design will give faster travel to the scene of a fire by allowing faster cornering: at a gross weight of 8 tons 14 cwt, 45 m.p.h. is attainable in thirty seconds from rest. The turning circle of the 12ft 6in wheelbase vehicle is only 46ft: a longer chassis of about 15ft wheelbase is available for turntable ladder appliances.



A "Firemaster" complete with 1000 g.p.m. main and 75 g.p.m. first-aid pumps, located in the nose to avoid slow reversing manœuvres. Notice the irregularities for suspension testing in the background

"Fluted Core" Radomes

GLASS fibre radomes are being manufactured by Bristol Aircraft, Ltd., by a new "fluted core" process which is the result of research and development work on reinforced plastics structures carried out by the company during the past few years. This fluted core process consists basically of a sandwich formed by two outer walls moulded integrally with intermediate corrugations or cells. One of the new radomes can be seen in the accompanying illustration.



"Fluted core" radome for Bristol "Britannia"

The sandwich is made up by laying glass in a mould and packing flexible wax mandrels or formers, wound with glass cloth tape, between the separate surfaces of the two skins. After the resin has been injected—it can be either cold or hot setting—the mould is opened and the moulding removed and placed in an oven for post-curing of the laminate. During this post-curing operation the wax mandrels are melted out.

In the making of a radome, the outer skin of glass cloth is laid in the female half of the mould and the inner skin laid on the male mould. The two half-moulds are then located in position and locked together by clamping bolts, after which resin is injected under pressure from the bottom of the mould. A cold setting resin is used and allowed to cure in the mould before post-cure treatment in an oven.

With this method of construction, fluted core radomes can be produced at considerably less cost than by earlier processes. It uses moulds fabricated in glass laminate, which eliminates need for expensive machining operations, and, as the whole manufacturing cycle is relatively simple, a minimum number of skilled man-hours is required to complete the job. As the radomes are moulded integrally they are stated to be much stronger than "built up" structures, whilst they have much higher resistance to impact damage and can be consistently moulded to fine limits of dimensional accuracy.

Industrial and Labour Notes

Human Sciences in Industry

Last year, the Department of Scientific and Industrial Research formed a Human Sciences Committee. That committee is the successor to two committees on Human Relations and Individual Efficiency in Industry. The D.S.I.R. has recently announced that the Human Sciences Committee will continue to support research in psychology, sociology and allied fields, such as industrial administration and operational research. The committee considers that it is important to encourage both basic and applied research in order to promote the growth of psychology and sociology and to make further contributions to the solution of the practical problems of industry and society.

The Human Sciences Committee, it is stated, is taking up proposals for research on a relatively large scale from certain well established groups covering between them the whole field from experimental psychology to sociology. It is hoped, therefore, that groups will exist capable of developing a co-ordinated programme of research rather than relying on two- or three-year projects. Ordinary short term projects are still being supported and, so far, the committee has approved applications for research on such topics as reading efficiency, inspection, the management of technical change and innovation and the problems of the transition from school to work. But it is anticipated that, even when a substantial number of grants have been awarded to the universities and other research bodies, there will remain topics on which insufficient or no research is being conducted. The D.S.I.R. is therefore making a survey of research needs from the point of view of industrial problems and the development of psychology and sociology. A research team has already submitted a draft report dealing with the effect of automation and higher mechanisation on the operative's job.

Industrial Relations

On Thursday and Friday of last week, the British Employers' Confederation held a conference, in London, of 300 representatives of its member firms to discuss industrial relations. The conference was opened by the Minister of Labour, Mr. Iain Macleod, who said that redundancy and the threat of it were very much the affair of the worker. Whilst the employer must decide how much could be said about it, it was clear that he was not likely to have a happy and efficient working force if his employees felt that they were under the shadow of possible sudden and arbitrary decisions to discharge them. There was a good deal to be said for the view, the Minister added, that in the long run industrial peace could not be established except on the basis of the full participation of both sides of industry. What he thought must be accepted by all was that compulsory arbitration could not be imposed on industry if industry itself was not broadly prepared to accept it.

The discussions at the conference were based on a report prepared by the Confederation's industrial relations committee. This report suggests that the four interrelated subjects affecting industrial relations to-day are the present economic situation ; the methods of fixing wages and their repercussions on the economic situation ; the changing pattern of industry resulting from technical change and from economic and political developments in this country and overseas, and the influence of employers' organisations and trade unions on the country's industrial life and development. In some comments on the present economic situation, the report says that " the evidence of increasing difficulty and keener competition in overseas markets " is a matter of the " most immediate industrial significance." That the balance of trade has continued to be relatively favourable is due principally to the considerable movement in favour of this country of the terms of trade. This year, the volume of exports has been over 3 per cent below that of 1957 although exports to North America have been very well maintained. Demand at home has also slackened, a factor due to some extent to the anti-inflationary measures taken a year ago.

Nevertheless, the report continues, the average of retail prices has risen about 2 per cent during the past year and wages have continued to increase appreciably faster than output, so that average labour costs have continued to rise. The continued rise in wages and prices and the fact that the demand for skilled labour is still generally in excess of the immediately available supply are the two main, though inter-related, aspects of the situation which are of direct significance in the field of industrial relations. It has to be recognised, the report goes on, that the resistance of employers to wage increases which inevitably put up their costs has for some years been weakened by the belief—hitherto generally borne out by experience—that increased costs can in inflationary conditions be passed on to customers. No matter how easy it may be in times of brisk business to raise basic wage rates, there is very strong resistance by trade unions to their reduction when the tempo of business slackens. Pre-war experience suggests that trade unions will generally tolerate quite a high level of unemployment before they feel able to agree to wage reductions. The avoidance of the development of any serious unemployment, the report adds, is an objective to which all parties subscribe. The main threat to the continuation of a high level of employment comes from the possibility of our being beaten in competition in overseas markets.

Railway Economics

Last week a conference of European Ministers of Transport was held in London, and last Friday evening the Ministers were entertained to dinner by the British Transport Commission. In a speech on that occasion, Sir Brian Robertson, the chairman of the Commission, told the guests that they were visiting British Railways at a critical and difficult time.

Sir Brian said that large sums of money were being spent on railway modernisation, but as yet they had scarcely begun to pay dividends. There was little profit to be had from a scheme of electrification when only a small part of it was complete ; only when the whole section was turned over to electric traction did it produce the large reward. There was little profit, Sir Brian added, to be had from putting a score of diesel locomotives on to a section which required 200 ; only when all steam had been eliminated from that section did the big results appear. That was why it was so important that modernisation, once started, should be pressed forward steadily and swiftly. The present time, Sir Brian continued, was a difficult one in another way. Instead of selling and moving freely, coal was being put to stock in large quantities. The steel industry also was producing considerably below capacity and below the level of 1957. That situation, Sir Brian remarked, was not peculiar to this country for the problem of surplus coal stocks had recently been the subject of special meetings in Luxembourg. Moreover, the fall in the level of steel production had caused anxiety both in the U.S.A. and in Europe. Traffic from the coal and steel industries, Sir Brian went on to say, was the very bread of life to the railways. The experts had assured railway operators that the situation was a temporary one and would improve. No doubt that was so, Sir Brian commented, but British Railways had no resources to cushion them against the effects of such a sudden blow which was " hurting a lot."

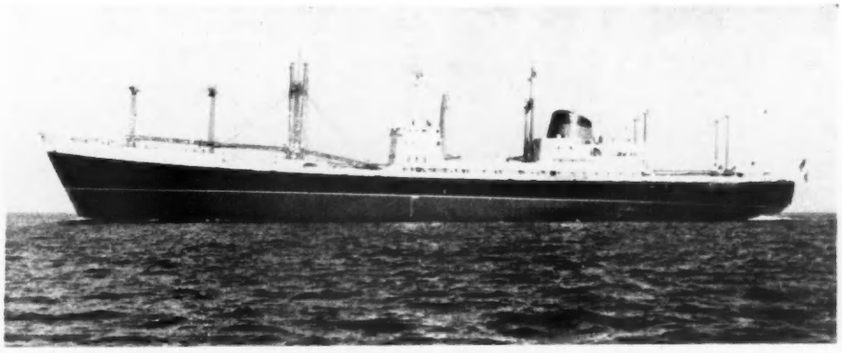
Finnish Steel Works Mission

A Finnish mission, led by Mr. Väino Leskinen, Minister for Social Affairs in the Finnish Government, visited this country last week to discuss with British manufacturers the equipment requirements of a £20,000,000 iron and steel plant which is to be built in northern Finland. The members of the mission were the guests of the Metallurgical Equipment Export Company, Ltd. The projected steel plant, it is stated, will be used to develop extensive iron ore deposits at Kolari, in Lapland. A state-sponsored company, Otanmäki Oy, is responsible for the undertaking. The plant is being designed for an annual output, in the first stage, of 100,000 to 120,000 tons of finished plates, building up ultimately to approximately double that output and including tinplate and black sheet. Before the mission left London last Monday, Mr. Leskinen said he thought there was " every reason to continue the discussions " which had been begun with the British consortium.

Wrought Non-Ferrous Metals

A meeting of the steering committee of the International Wrought Non-Ferrous Metals Council, attended by delegates from thirteen Western European countries, was held in Paris on October 16. The trend of home and export business was discussed. It was stated that while there had been a tendency for orders booked to decline in the third quarter of this year, there was a general feeling in all countries that the " orders booked " position would not deteriorate and might even improve in the last quarter.

The International Council has arranged for a meeting to take place in Paris on November 12, between its members and representatives of the committee of the London Metal Exchange, at which the functions of the London Metal Exchange and the services which it could provide will be fully expounded. The International Council, through its members, has urged that the work of the International Organisation for Standardisation should make quicker progress in the field of the international standardisation of copper and copper alloys. It is hoped that speedy progress will be made in this direction, in view of the establishment of a European Common Market and the likely creation of a European Free Trade Area.



Cargo Ship M.S. "Magellan"

THE cargo liner which has been completed recently at the yard of the Chantiers et Ateliers de Provence, Marseilles, for the Compagnie Générale Transatlantique, is the first of four cargo ships having a design based on the "Equateur" class built some six years ago, and is destined for South Pacific service. A deadweight of 9600 tons is carried on a loaded draught of 26ft 11in and the following dimensions :— Length overall 499ft, length between perpendiculars 457ft 8in, moulded breadth 61ft 8in, and depth to upper deck 39ft 0¾in. Twelve passengers are carried in single and two-berth cabins, in addition to a crew numbering fifty-seven, and the whole of the accommodation is air conditioned. The bale capacity is 550,000 cubic feet and the refrigerated capacity is 16,000 cubic feet. Of closed shelter deck design, the ship has three decks and is almost entirely welded, and subdivision is by means of seven watertight bulkheads. Erman hatches are fitted at four of the holds, and a Mège hatch at the fifth hold, while the derrick complement includes 5-ton and 10-ton derricks, with one 30-ton and one 20-ton heavy lift units, all served by electric winches. Other deck machinery includes a windlass and five 6-ton capstans. Electricity supplies for the ship services and auxiliary machinery are provided by three 350kW, 220V d.c. diesel-driven generators and there is one 30kW diesel-driven emergency generator. A service speed of 16 knots is maintained by a Provence-Doxford Mark 65L.B.D.6.5 opposed-piston oil engine, supercharged on the Brown-Boveri system, and rated to develop 9000 b.h.p. at 120 r.p.m. As can be seen in our illustration of the ship on trial, the engine-room is placed well aft and just forward of No. 5 hold.

Semi-Reflecting Glass

A product of special use to the iron and steel industries has been developed and placed on the market by Union des Verreries Mécaniques Belges, S.A., Quai de Brabant 29, Charleroi. It is a semi-reflecting glass with a very high degree of reflection in the infra-red. This is achieved by depositing a coating on one side of the glass, which for protection is then assembled together with an ordinary sheet of glass, in a so-called "Polyverbel" unit. The two glass plates are separated at the edge by a plastic spacer, which also performs the function of a seal. The air in the intermediate space is dehydrated.

Taking into account the high thermal stresses and rough usage to which the glass is subjected in the iron industry, it is in general necessary to use safety glass (toughened glass), with five to six times the shock resistance of ordinary glass. This fact, however, imposes a size limitation—units may not exceed 123cm by 81cm. Up to 252cm by 168cm larger units can, however, be obtained, if only one sheet needs to be toughened, or by assembling two toughened sheets, one coated and the other plain, so that they touch. In that case, the unit has a stainless steel frame.

The transmission of ordinary sheet glass is substantially the same over the visible and infra-red ranges from 0·4μ to 1·2μ, amounting to up to 90 per cent in the visible range and gradually falling away to 70 per cent in the infra-red. On the other hand, transmission through semi-reflecting glass is stated to reach a maximum of about 55 per cent in the yellow-green (0·55μ) and then to drop to just over 20 per cent at 1·1μ. Reflection, however, increases from a minimum of about 25 per cent at 0·5μ to nearly 60 per cent at 1·2μ. Absorption remains small throughout, and in the infra-red region amounts to 10 to 20 per cent, so that differential thermal stresses at the edge, where the frame partially obscures the glass, are kept small and the glass will not crack.

Spinning Machine for Large Pipes

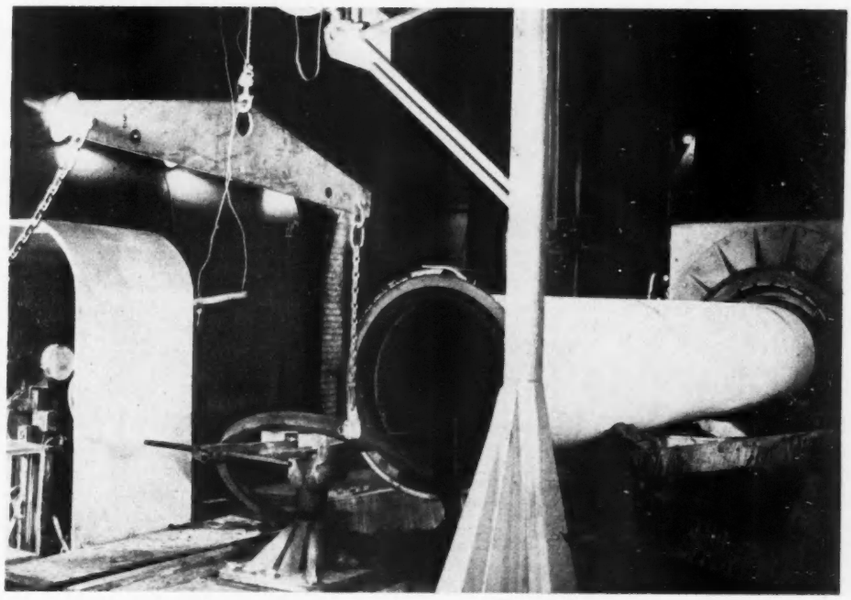
Development work has been going on since 1953 at the Société des Fonderies de Pont-à-Mousson, to perfect the spinning of cast iron pipes of 700mm bore and over in metal moulds. This technique, which has been practised for many years for small and medium pipes, is stated to offer to users of large bore pipes increased standards of quality in respect of accuracy of shape, soundness of metal and improved mechanical characteristics. The machine illustrated below, which has been designed and built entirely by Fonderies de Pont-à-Mousson, is suitable for casting pipes ranging from 700mm to 1250mm bore diameter in lengths of 7m. It comprises a box-shaped casing of welded construction which carries the water-cooled mould. The mould is supported by a set of four rollers, two of which are driven by two 50 h.p. d.c. motors. The latter are variable-speed motors normally operated from d.c. mains, but a rectifier set is provided to supply power from the a.c. mains in case of emergency.

In carrying out the casting operation, the pipe remains in its place while the casting machine is fed longitudinally by hydraulic means. The casting ladle is tilted hydraulically. Output capacity of the plant is quoted as two and a half pipes of 1250mm bore diameter, each weighing 6000 kg, or five pipes of 800mm diameter, each weighing 2600 kg.

Before beginning to cast, the mould is sprayed internally with a silica and deoxidiser coating. First, the mould is brought to the correct temperature, which is noted. An aqueous silica mix is deposited next, followed by a deposit of deoxidiser. The mould temperature during casting, the temperature and analysis of the iron, and the cooling times are recorded. After removal from the mould the pipes are subjected to a strict inspection. It is claimed that by attending to the above factors, skin drilling of the cast iron is avoided, and pipe distortion is obviated since the process achieves self-annealing inside the mould.

Reorganisation of Swiss Watch Industry

For the last several months work has been in progress to reorganise the Swiss watch and clock-making industry, in order to improve manufacturing techniques and sales methods, so as the better to meet the present weakening of its markets and the increased competition from abroad. At present, the industry is organised in four groupings : the Federation Horlogère (association of watch manufacturers), the Ebauches S.A. (manufacturers of movements), the UBAH (Union des Branches Annexes de l'Horlogerie—components and accessories), and the Association des Fabricants des Montres Roskopf. It was decided to unite all these associations under a single roof organisation, the Commission des Organisations Horlogères (C.O.H.) who will carry out further reorganisation measures in co-operation with various *ad hoc* committees. These measures, some of which are already provisionally in force, include increased standardisation and interchangeability, as well as the grouping together of smaller manufacturers into larger units.



Spinning machine for the casting of iron pipes of from 700mm to 1250mm bore diameter in lengths of 7m. The rotating pipe remains in place while the casting machine is fed longitudinally by hydraulic means. Hourly output capacity is stated to be two-and-a-half pipes on maximum diameter, each weighing 6000 kg

Progress in Controlled Thermonuclear Research in the United States

BY OUR AMERICAN EDITOR

No. III—(*Concluded from page 627, October 17*)

During the past seven years the U.S. Atomic Energy Commission has been engaged in a research programme aimed at producing power from controlled nuclear fusion. The research effort is necessarily shaped by the physical conditions that must be achieved in order to realise net power from fusion. These physical conditions apparently have been defined, and promising methods of achieving them have been formulated. Significant progress has been made along several lines of effort ; each is contributing knowledge to the art of controlling fusible material for the achievement of a self-sustaining thermonuclear reaction. This article describes some of the more important classes of experimental devices developed at the four major laboratories working in the field and the principles and methods applied in these machines to overcome the two fundamental problems of attaining extremely high temperatures and of confining the plasma.

The Stellarator Programme

THE essential aspects of the stellarator approach to the controlled thermonuclear problem were conceived by Lyman Spitzer, Jr., of Princeton University, an astrophysicist by background. A research programme based on the stellarator concept was initiated under Spitzer's direction at Princeton's Forrestal Research Centre in 1951. The term "stellarator" was coined to indicate a particular class of devices in which it is hoped that stellar temperatures can be generated. Stellarators may be described briefly as devices in which ionised gas is confined in an endless tube by means of a very strong externally applied magnetic field.

Since charged patricles are "tied" to magnetic lines of force and execute tight spirals around the lines, they can be kept away from the walls of a tube through the establishment of a very strong longitudinal magnetic field which can be produced by current-carrying coils encircling the vacuum chamber containing the low-density plasma. The field will not inhibit the motion of particles in the longitudinal direction along the lines of force. The problem of end leaks might be solved by simply bending the vacuum chamber or tube into a torus. The magnetic lines of force then would be closed circles and the confinement should be perfect except for particle diffusion, or drift, across the field as a result of repeated collisions. However, a simple toroidal geometry will not work, because the magnetic field intensity is not uniform over the cross-section of the tube. This non-uniformity leads to another type of particle drift, toward the walls, of ions in one direction and electrons in another. The separation of electrical charges, which cannot be readily neutralised, produces a strong electric field which, together with the magnetic field, pushes both positive ions and negative electrons toward the outer wall of the tube.

This difficulty was foreseen and a way was found to avoid it and still utilise the basic confinement characteristics of a strong longitudinal field. It was shown theoretically that the electromagnetic drift described could be prevented by twisting the toroidal tube into the form of a figure eight (see illustration in THE ENGINEER, September 12, page 408). The magnetic field then is characterised by an abstract property called a "rotational transform." In such a geometry a single magnetic line of force, if followed along the stellarator tube, does not close on itself in a single turn, as in the case of the simple torus, but is displaced by an angle related to the degree of twist built into the tube.

In following the lines of force along the tube, they thus rotate slowly about the magnetic axis, which lies close to the axis of the tube ; the lines resemble the twisted strands of a rope. This permits charge separations to be neutralised by a flow of charged particles along the lines of force. Consequently, the rotational transform plays a vital part in the operation of the stellarator.

Subsequently it was found that a rotational transform could be introduced without twisting the tube. Two sets of external magnetic coils are required in this alternative arrangement—an outer circular set, and an additional inner set of spiral coils having a very large pitch. The helical coils cause spiralling of the lines of force, and therefore accomplish the same end as twisting the tube. This second method has the advantage that it also provides a configuration which tends to be stable against those disturbances known as hydromagnetic instabilities. Detailed theoretical studies have shown that a stellarator should be capable of confining a plasma for an experimentally interesting length of time, provided the heated gas remains relatively quiescent. However, if turbulence, oscillations or other forms of unsteadiness appear, the effectiveness of the magnetic field in confining the particles is reduced, and the plasma may cool off through contacts with the wall. For the sake of experimental convenience, the confining magnetic field is usually applied in pulses, but there is no basic reason why the field has to vary with time. The stellarator, in its ultimate form, once ignited, is envisaged as a steady-state device.

Two stages appear to be necessary in heating the plasma in the stellarator. The first stage is "ohmic heating." To produce the current, an iron core is used to encircle the tube. A time-varying current is passed through an auxiliary winding around the core : the ionised gas in the stellarator tube forms the secondary winding of this transformer. Such a current production also is used in toroidal pinch devices : however, the stellarator currents are of smaller magnitude, since the current does not also have to provide the means of confinement. The pinch type of magnetic fields in the stellarator are weak compared to the main longitudinal magnetic field. However, the current must be kept below the so-called "Kruskal limit" in order to avoid cancellation of the rotational transform. Fig. 11 is a simplified schematic diagram of a stellarator device.

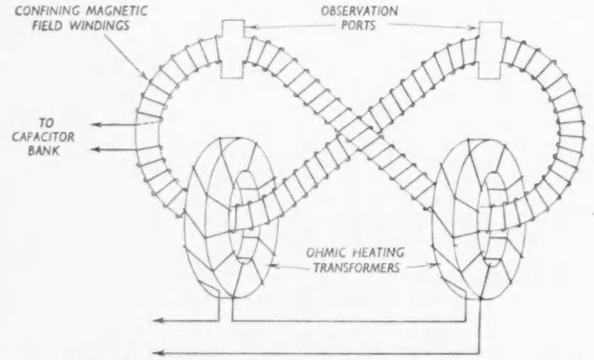


Fig. 11—Simplified diagram of a stellarator device at Princeton University

Calculations indicated that ohmic heating should result in achieving temperatures of about 1,000,000 deg. This was found to be true, but at higher temperatures than this the resistance of the gas falls to such low values that little heating can be obtained with the induced currents which can be achieved in practice. At this point, the ability of the plasma to conduct electricity is about twenty times as great as copper under ordinary conditions. To achieve the 100 million deg. temperatures required, the Princeton group plans to utilise a method called "magnetic pumping," which has been the subject of small-scale experimentation, but which requires a fairly high-temperature plasma to start with. This method consists of using a rapidly pulsating magnetic field in one section of the tube. Heat is produced by repeated compression and expansion of the plasma at radio frequencies which are of the order of millions of cycles per second. It appears that energy can be added to the gas at the most rapid rate if the pulsation period agrees with one of the natural periods of the gas, such as the time between collisions for a single particle or the time required for a particle to pass through the magnetic pumping section. Other r.f. heating methods which are being investigated involve the ion-cyclotron resonance frequency—the frequency with which the ion moves in a circular path in the presence of the magnetic field.

The stellarator is basically a fairly low-density device and is therefore very sensitive to impurities which tend to contaminate and cool the plasma. This has led to very intensive ultra-high vacuum work at Princeton, in an effort to ensure clean operating systems. Another approach to enhancing the purity of the gas involves the use of an additional modification of the complex magnetic field, called a "divertor." In a short section of the stellarator the magnetic field is shaped, by means of a bucking coil, so that the outermost lines of force are led radially out of the tube into a separate chamber. The purpose is to ensure that particles drifting slowly toward the tube wall, or from the wall toward the plasma, will be guided into this divertor. Impurities liberated by collisions of these particles with the wall will then be confined to the divertor chamber. They can be pumped away before they make their way back into the main discharge tube.

A number of small-scale stellarator devices has been built to investigate experimentally the central ideas of this approach. The first device was the "Model A," built in 1952. Since then there have been a succession of "B" machines. Stellarators, with their novel magnetic field configurations and elaborate heating schemes, are inherently very complex machines, which require a great deal of careful design and fabrication. The "B" machines operate on a pulsed basis and are powered by relatively slow capacitor banks. They operate in the millisecond range. A device of the B-2 stage was exhibited at Geneva. Also exhibited at Geneva were two small demonstrational stellarator devices, one a figure eight and the other a "race-track," or elongated torus.* Electron beams were used to illustrate the action of the magnetic fields produced by the several types of coils.

The experimental programme has demonstrated the basic validity of the confinement scheme. The devices are observed to retain plasma for a considerable time after ohmic heating currents have decayed. Ohmic heating has been demonstrated and studied in great detail. Interesting

* See THE ENGINEER, September 12, page 408, and September 19, page 448, for illustrations of these exhibits.

studies have been made of " runaway electrons " —electrons which somehow acquire abnormally high velocities. Radio-frequency heating techniques have not as yet been conclusively demonstrated, but are the subject of much effort at present. The beneficial effects of the divertor have been successfully demonstrated. The theoretical group at Princeton has made outstanding contributions to plasma theory in general, and to the study of instability phenomena in particular. For example, pinch instabilities were predicted in advance by Princeton theoreticians. The experimental group is making strong efforts to gather experimental information on the initiation and growth of instabilities, especially those of the electrostatic variety which may possibly affect the present stellarator devices.

As part of a long-range programme centred on the stellarator approach, a new laboratory complex is being established at Princeton. The first device to be housed in the new facility will be the " Model C," a " race-track " tube about 40ft in circumference and 8in inside diameter, equipped with helical stabilising windings. In line with the fundamental nature of stellarators, the power supplies for energising the confining field and for heating the plasma will be very large. Under a contract with Princeton, the Allis-Chalmers Manufacturing Company and the Radio Corporation of America are engaged jointly in the design, fabrication, installation and test of the device and the associated power supplies. Exploratory or preliminary experiments with the device are expected to begin late in 1959. The completion of the device is scheduled for late 1960. The " Model C " machine is appreciably larger and more powerful than the present " B " devices and will open the way for new and more meaningful studies of plasma behaviour. It is hoped that much longer confinement will be achieved and that temperatures of the order of 50,000,000 deg. will be reached. " Model C " will be strictly a research facility ; it is not expected to be a net power producer. It should help to provide valuable information on the hot plasmas which will be essential to planning the full-scale machines.

The Magnetic Mirror Programme

The tendency for charged particles moving in a non-uniform magnetic field to be repelled from regions where the magnetic field is strongest has been known for a great many years. The use of this general principle as the basis for a method of confining an ionised plasma—the method designated as the magnetic mirror approach—was suggested by H. F. York, and developed largely by R. F. Post's group at the University of California Radiation Laboratory in Livermore. The programme based on the magnetic mirror principle has been in existence since 1952.

In its simplest form, a mirror machine consists of a long, straight tube provided with current-carrying coils which produce a strong magnetic field inside the tube. In the central transverse plane, the magnetic lines of force are parallel to the axis of the tube. At the ends of the tube, however, the magnetic field is made much stronger, through the use of extra coils or higher currents. These regions of stronger field, where the magnetic lines of force are brought closer together, are called " magnetic mirrors." A charge particle spiralling around a magnetic field line tends to be reflected from the mirror regions. Thus, the relatively weak field region between the two mirrors effectively traps charged particles. The magnetic field configurations of mirror devices led to the term " magnetic bottle," for the field is really shaped like a two-ended bottle, with the mirrors defining the necks at either end. Fig. 12 is a diagram of a typical mirror device.

Magnetic mirror devices, or " Pyrotrons," as they are sometimes called, are similar to stellarators in that both rely on strong externally applied fields. In a stellarator, end leaks are prevented by getting rid of the ends, i.e. by bringing the ends together to form a continuous tube. In a mirror machine, end leaks are minimised through the use of the mirrors, i.e. the strong regions at either end. While mirrors do not provide perfect containment, they do allow the vacuum chamber of the device to retain the very considerable advantages of being cylindrical rather than toroidal in shape. The containment of particles in a mirror device is most perfect for those particles which have relatively high components of velocity at right angles to the magnetic lines of force and relatively low components of velocity along the field lines. Particles satisfying these conditions could remain trapped almost indefinitely, if it were not for inter-particle collisions. These collisions cause repeated deflections of particles into paths with insufficient spiral to ensure a containment of the particles and, hence, particles eventually escape along the lines of force through the mirrors. No instabilities have been observed in magnetic mirror devices at the temperatures and densities attained thus far. It is not known with certainty, however, whether or not the plasma will be fully stable at the much higher densities and temperatures which are ultimately required.

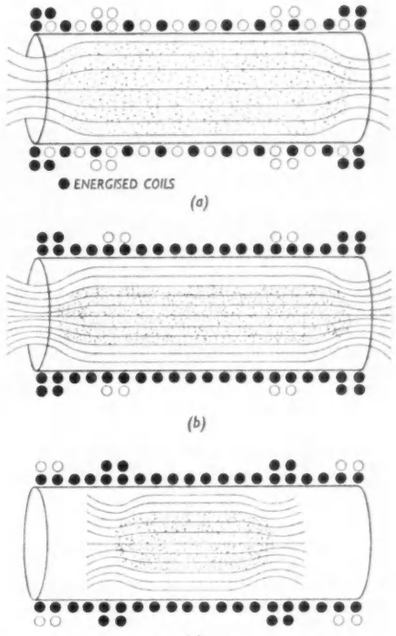


Fig. 12—Diagram of magnetic mirror device, showing heating effect (a) with plasma injected while field is weak ; (b) with field intensity increased with radial compression of plasma ; (c) with longitudinal compression by inward movement of magnetic mirrors

The principal heating process used in the mirror programme is that associated with the compression of the plasma through an increase in the intensity of the magnetic field. This works in the following way : As a magnetic field is caused to increase, an electromotive force is set up which acts to increase the velocity of particles spiralling around the lines of force. Actually only the component of velocity in the plane perpendicular to the field is increased ; velocity along the lines of force is unaffected. The following expression holds to a good approximation ; W_n/H = a constant, where W_n is the kinetic energy associated with motion normal to the field, and H is the field intensity. Thus, increasing the field adiabatically adds energy to the particles, and in a way which enhances the confinement. Increasing the field also makes the particle orbits smaller and can be said to bring all the field lines closer to the axis of the device. Hence a physical compression of the plasma accompanies the heating, Fig. 12(*b*).

Another way to compress and heat the plasma is to compress it longitudinally, i.e. to control the currents in the external coils so as to cause the magnetic mirrors to move toward each other. The plasma is then compressed as though it were caught between two moving pistons and strong heating ensues, Fig. 12(*c*). The attainment of high plasma temperatures can be made easier through the injection of fairly energetic ions. Typically, injection occurs through the ends of the device—the necks of the bottle. Causing the field to increase continuously during the injection period prevents particles reflected at the other end from coming back and striking the source. The field cannot be made to rise indefinitely, however, and there is a limit to injection currents ; therefore, there is a limit to the ion density that can be built up in the device by this process.

Three main lines of development are being pursued in the Pyrotron programme at Livermore : high compression experiments, transfer and multiple compression, and end-injection of energetic ions.

High Compression Experiments.—In this set of experiments, relatively cold plasma is trapped in

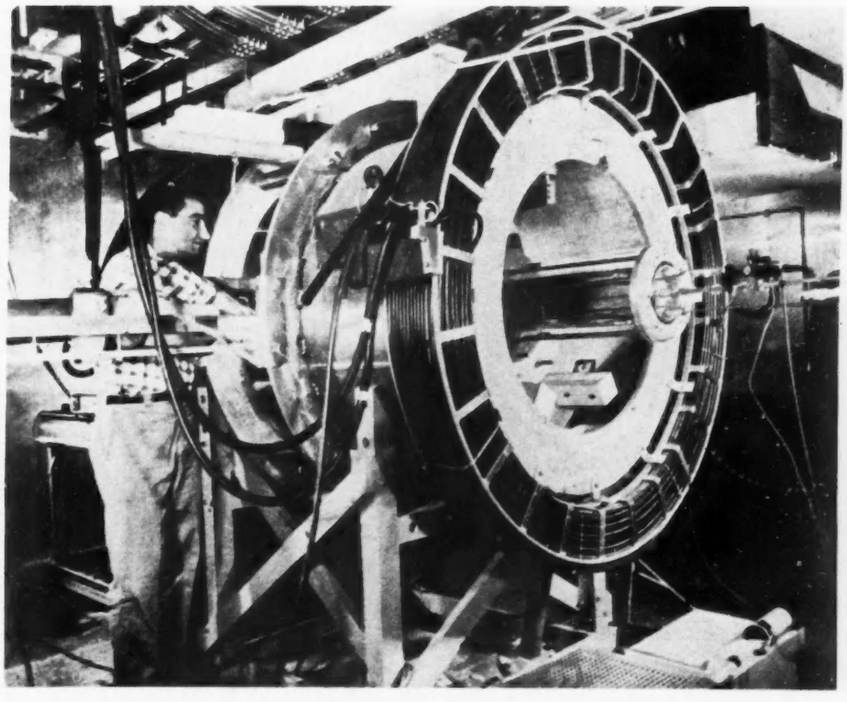


Fig. 13—High compression experiment at the University of California Radiation Laboratory causing the heating of electrons to temperatures of about 10,000,000 deg. Cent.

a weak magnetic field and subsequently heated by compression. The compression time is made short compared to the times anticipated for the loss of the trapped particles. The main losses to be considered are due to collision leakage through the mirrors and to charge-exchange. These experiments (Fig. 13) have demonstrated the confinement of plasma for periods of several milliseconds, the radial compression of plasma and the heating of electrons in the plasma to temperatures of about 10,000,000 deg. A continuing effort is devoted to developing means of measuring the energy distribution of the positive ions and of injecting plasma with higher initial temperatures. It is hoped that these efforts will lead to final plasma temperatures of the order of tens of millions of degrees, with sufficient plasma density to produce a substantial yield of thermonuclear neutrons.

Transfer and Multiple Compression.—In this experiment, compression of initially cold plasma occurs in three stages. Plasma is injected into an 18in diameter vessel provided with a weak mirror field. The plasma is then compressed radially by increasing the field. Through the manipulation of the confining field, the plasma is then transferred to a neighbouring 9in diameter vessel, there compressed further, and transferred to a third still smaller 3in diameter vessel, where a high field compression is applied. This transfer sequence moves the plasma several feet from the point of origin and is intended to separate the deuterium ions from heavy ion and neutral atom contaminants. Plasma diagnostics performed during the operation show that compressions and transfers of the plasma injection, using a gun which emits a blob of plasma at high velocity, has been developed. It is expected to provide a relatively hot plasma at the first state so that, after compression, very high plasma temperatures and densities can be attained in the small volume. Fig. 14 shows the apparatus being used in this type of experiment.

End-Injection of Energetic Ions.—In this experiment, relatively high energy (5–10 keV) deuterium ions are injected from a source just inside one of the magnetic mirrors. The ions are injected in a direction nearly perpendicular to the magnetic lines of force and spiral onward into the longitudinal centre of the device. The field intensity must increase steadily during the injection period in order to provide positive trapping. At the end of the injection period, the magnetic field continues to rise so that the ions are heated adiabatically by compression to about five times their initial energy, which, in the case of the device being used at present, should be about 25 keV. This method of injection ensures that ions retained for the full cycle will automatically have energies corresponding to about 300 million deg. The main problem is to inject and retain enough energetic ions to form a plasma of sufficient density for the production of an interesting thermonuclear yield.

Transient mirror devices of the type being used at the University of California Radiation Laboratory are very complicated pieces of apparatus, and experimentation with them is beset with the usual assortment of difficulties. The devices are particularly sensitive to the effects of impurities and a great deal of effort has gone into finding ways to minimise the influx of contaminants. Post's group has been responsible for studying the excitation radiation problem in some detail. Much stress is laid on careful diagnostic work. In spite of the present technological difficulties, the magnetic mirror devices are considered very promising. They make excellent devices for research in plasma physics and incorporate a high degree of flexibility. The mirror geometry, because of its simplicity and convenience, has found applications elsewhere. It is used at Oak Ridge in connection with the study of high-energy injection and also at Los Alamos and at the Naval Research Laboratory for the confinement of plasmas produced by colliding shock waves.

High-Energy Injection

The problems involved in heating a low-temperature plasma up to the extreme temperatures required for thermonuclear reactions are known to be formidable. Great difficulties have been encountered in reaching the relatively modest temperatures achieved thus far. By adding energy to charged particles moving essentially at random within a confining field, attempts are made to bring the plasma up to high temperatures through intermediate regions in which : (*a*) the confinement may be inadequate and (*b*) other energy loss processes such as excitation radiation and charge exchange are particularly detrimental. There is some evidence also that heating processes can encourage the initiation of instability phenomena. However, in principle, there exists a second method, other than heating a low-temperature plasma for obtaining high-temperature ions. It consists of first adding energy directly to ions, and then trapping or confining them and allowing their motion to become random. One can easily produce a beam of ions having sufficiently high kinetic energy by means of a conventional particle accelerator. The problem then becomes one of using these energetic ions to construct a hot plasma, in which ion motion will be random rather than unidirectional as in accelerator beams. The mirror machine programme at the University of California Radiation Laboratory has made use of moderately energetic ions trapped by increasing the intensity of magnetic fields. However, the use of highly energetic ions is the key principle in the approach to thermonuclear power being investigated by the Oak Ridge National Laboratory. It was perhaps a natural path for this laboratory to pursue in view of the extensive experience developed at Oak Ridge over the past fifteen years in the electromagnetic separation of isotopes.

The most promising methods of trapping a charged particle in a magnetic field appear to involve either : (*a*) using a time-varying field, as discussed earlier, or (*b*) causing the charge-to-mass ratio of the particle to change while it is moving through the field which then need not be changing with time. The latter method is being employed in experimental work at Oak Ridge in the following way : molecular deuterium ions, each consisting of two deuterons and one electron, are supplied at high energy in the form of a beam from an accelerator and injected across a magnetic field into a vacuum chamber. Ordinarily an ionised molecule so injected will move in a large circle, if the field is uniform, and return to strike the source from which it was injected. Trapping can occur, however, if the molecular ion is dissociated or broken up at some suitable point in its orbit, thereby altering the charge-to-mass ratio.

The molecular ion can be dissociated into two particles : a single positively charged deuteron and a neutral deuterium atom, consisting of the remaining deuteron and the electron. The neutral atom is not acted upon by the magnetic field and immediately escapes. The positive deuteron, on the other hand, with the same charge and velocity but only half the mass of the original molecular ion, will move in a new orbit which has a radius only half as large. Consequently, it cannot come back and strike the source ; it will continue in a circular orbit. The scheme would be of merely academic interest unless highly efficient means were actually available for dissociating molecular ions at the proper point. The means was suggested by John S. Luce, who discovered that an unusual type of electrical discharge—a high-current vacuum arc—could dissociate molecular ions with remarkably high efficiency over a wide range of ion energies (see illustration on page 408, THE ENGINEER, September 12). A complete break-up of the molecular deuterium ion into two deuterons and an electron also is observed.

Oak Ridge has undertaken an experimental programme based on dissociative trapping of energetic ions. The programme makes use of magnetic mirror geometry, rather than a uniform field, in order to provide a degree of confinement in the direction of the magnetic lines of force. Fig. 15 gives a simplified diagram of this method. In practice, the arc is not situated on the axis of the vacuum chamber as shown, but is off-centre, so that the trapped atomic ions initially follow a circular path concentric with the axis of the device and stay well away from the walls. The injection current and magnetic field remain constant in time. This has led to calling the Oak Ridge device DCX, which stands for Direct Current Experiment. In the present DCX device, molecular ions are injected at 600 keV, yielding 300 keV atomic ions. The injection currents employed are in the milliampere range. Fig. 16 is a photograph of the DCX machine.

The trapped ions do not stay in an organised ring indefinitely. The orbits spread out somewhat due to energy losses and the non-uniform nature of the confining magnetic field. Moreover, there are competing processes which serve to limit the build-up of the circulating beam of particles. The most important one is charge-exchange, in

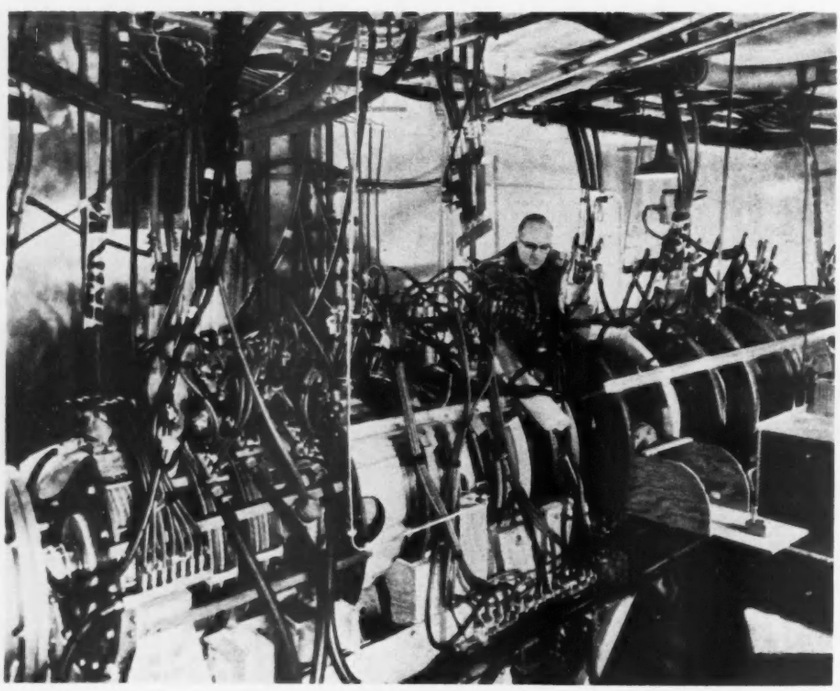


Fig. 14—Magnetic mirror machine used for transfer and multiple compression experiments at the University of California Radiation Laboratory

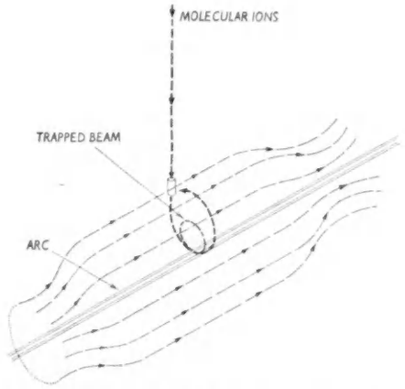


Fig. 15—Diagram of molecular beam method of trapping ions by dissociation employed at Oak Ridge

which a fast ion picks up an electron from a slow neutral atom, becomes neutralised, and so escapes from the magnetic bottle. At 300 keV, the charge-exchange cross-section is very low compared to its value at lower energies, but it is still to be reckoned with. Charge-exchange losses are minimised by pumping the system down to very low pressures initially and keeping the density of neutrals as low as possible. The trapped beam has a pumping action, since the fast ions can ionise neutrals with little loss in energy. At 300 keV, the ionisation and charge-exchange cross-sections are such that, on the average, a fast deuteron will ionise about twenty atoms before being lost through charge-exchange. By decreasing the neutral background pressure of the vacuum chamber, or increasing the ion injection rate, or a combination of both, a critical condition known as " burn-out " can be reached—the neutral atoms are being ionised as fast as they enter. The ion density can then be built up rapidly. With a spherical plasma volume whose radius is that of a 300 keV deuteron in a magnetic field of 10,000 gauss and with a background pressure of 10^{-6}mm of mercury, an atomic ion injection rate of 80 milliamperes is required to achieve burn-out. The better the vacuum, the lower the injection current can be.

Following burn-out, the ions are expected to lose energy by colliding with and heating cold ions and the cold electrons that will be drawn in to provide the overall charge neutralisation. While this degradation of energy is taking place, the density of ions also builds up ; they will scatter by collision and their motion will tend to be random. Thus far, the ion densities have been insufficient to explore experimentally the " randomising " of the particle motion.

As the plasma forms it will, of course, be subject to particle losses through the magnetic mirrors and to bremsstrahlung losses. It is not yet known whether the system will exhibit any serious instabilities. It is extremely difficult, on the basis of present knowledge, to estimate what the final densities and temperatures will be in a device like DCX. If a plasma can be formed in it at all, one might expect ion temperatures of the order of 100 keV. This is well above the D-D ignition temperature, but the DCX is strictly a research device, cannot contain charged reaction products and will not come within many orders of magnitude of being a net power producer. The general method virtually ensures the presence of ions far superior in energy to those needed for thermonuclear reactions, and the hot low-density plasma should have good confinement properties.

After the arc has helped to form the hot plasma, it could be turned off and the plasma could be fed by the break-up of molecular ions in the plasma or even by the injection of cold gas. The compression of the plasma, as in the University of California Radiation Laboratory magnetic mirror programme, would probably be necessary if a DCX-like machine were to be made capable of containing its reaction products, thereby making ignition of the plasma possible. This method of igniting a plasma does not appear to be limited to a magnetic mirror geometry.

Other Research Programmes

In addition to the four major approaches outlined previously, there are several other ideas which have been considered at one time or another. Some of the ideas have been carried to a point of preliminary experiment and dropped for lack of promise, or perhaps put on the shelf for the time being in favour of more promising efforts. Some are undergoing active investigation at the present time and may well lead to results of appreciable significance. Among the small but noteworthy efforts now being pursued are those which involve shock heating of the gas. The use of shock waves was considered at an early stage in the Sherwood programme, but shock techniques were not sufficiently developed at the time to make the method attractive.

The Naval Research Laboratory, in a programme co-sponsored by the Atomic Energy Commission, undertook a small shock-tube programme in 1955, aimed at studying the properties of high-temperature plasma and investigating the use of shock tubes for the production of such plasmas. Substantial advances have been made by way of increasing the temperatures attainable by shock techniques and finding a method of propagating shocks at appreciably lower densities than had previously been thought possible. With the achievement of temperatures of the order of 1,000,000 deg. through the colliding shocks, attention has turned to the possibility of magnetically confining and compressing the shock-heated plasma. Neutrons are now being produced at the Naval Research Laboratory in plasmas operated thus.

The Los Alamos Scientific Laboratory recently has been conducting an experiment on shocks produced within a magnetic mirror field. In this experiment, neutrons have been produced by what appears to be shock ionisation and adiabatic compression in a mirror geometry. The apparatus was designed to operate with deuterium which had been ionised by shocks passing in the axial direction. However, the induced electric field associated with the time-rising magnetic field produced by the single-turn mirror coils themselves appears adequate for the initial ionisation, so that about 1000 to 10,000 neutrons per pulse are produced without the preheating shocks. If the mirror symmetry is spoiled by energising the two mirror coils at slightly different times, no neutrons appear. This suggests that plasma is indeed confined between the mirrors. The experiment is fairly new, and further studies are required to establish how many of the neutrons, if any, are produced by a direct acceleration in the tangential electric field and how many, if any, by thermonuclear reactions between deuterons confined during the peak of the field.

Theoretical work continues at all the major laboratories engaged in experimental programmes. Among the major areas of theoretical interest are the stability of various configurations of plasma confined by magnetic fields ; the nature and structure of boundary layers established between plasma and magnetic fields ; the electrical and thermal conductivities of plasma in the presence of a magnetic field ; and the structure and heating effects of shocks. The Commission sponsors a theoretical programme at New York University under the direction of H. Grad. The University's Institute of Mathematical Sciences has contributed to a theoretical understanding of shock wave phenomena and fluid dynamics in general. The New York University group is developing information in the complex field of magneto-hydrodynamics.

In addition to the major programmes, the Commission supports a variety of smaller contracts with universities and industrial companies. Some of this work is concerned with fundamental research in fields where the contractors have unique skills or experience. Other contracts involve the pioneering development of particular components needed at one or another of the Commission's major laboratories. Industrial organisations are taking an increasing interest in the controlled thermonuclear research programme. Some industrial companies, such as the General Dynamics Corporation, are undertaking research and development programmes in the field without Government support. Others have a more limited interest and are concerned primarily with making use of their particular talents in some restricted phase of the programme.

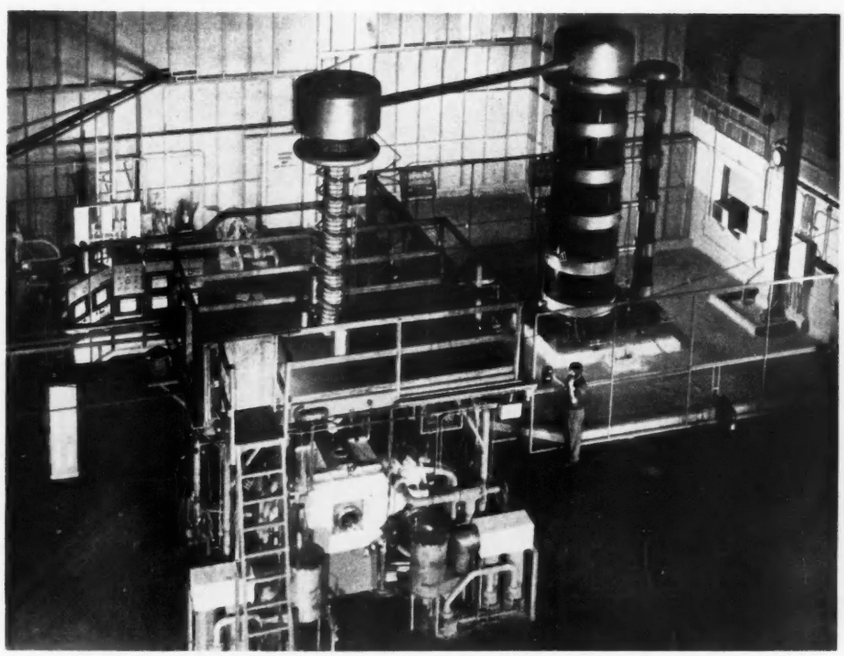


Fig. 16—Direct Current Experiment (DCX) at the Atomic Energy Commission's Oak Ridge National Laboratory. The O.R.N.L. approach in connection with thermonuclear research is aimed at producing a hot plasma by the steady state injection and trapping of energetic deuterons

---

Induced - Draught Cooling Tower.—An induced-draught cooling tower, known as the " Aquatower," is now being made by Heenan and Froude, Ltd., of Worcester, who, a little over three years ago, completed reciprocal arrangements with the Marley Company, of Kansas City, U.S.A., for the manufacture of water coolers. The " tower " utilises a single fan to draw air through two separate louvred sides (this is called double flow) and is available in several sizes up to a maximum capacity of 160,000 gallons per hour. It incorporates a series of nailless trays which can be easily installed or removed. The overall height of the " tower " is claimed to be approximately one-third that of other induced-draught towers of similar capacities. The dimensions of the largest (double cell) model are 21ft by 32ft by 7ft 8in high, exclusive of the supporting structure.

Personal and Business

Appointments

MR. TOM BLYTH has been appointed home sales manager of S. N. Bridges and Co., Ltd.

THE AMAR TOOL AND GAUGE COMPANY, Ltd., has appointed Mr. J. Urpeth as its Midlands representative.

MR. W. H. DEVENISH has been appointed deputy head of the member relations department of the Electrical Research Association.

MR. H. SMALLWOOD, chief accountant of Davy and United Roll Foundry, Ltd., has now also been appointed secretary of the company.

CAPTAIN P. V. HOARE, F.R.Ae.S., M.I.C.E., has been appointed consultant to Tiltman Langley, Ltd., by arrangement with Westland Aircraft, Ltd.

MR. G. E. WALKER has been appointed director of central services of Associated Electrical Industries, Ltd. He will continue to be secretary of the company.

MR. R. W. JAY has been appointed spares manager of Bristol Aircraft, Ltd., in succession to Mr. C. A. R. Biddle, who is taking up an appointment with Tube Products, Ltd.

GEORGE KENT, Ltd., has announced the appointment to the board of its Belgian subsidiary company, Kent-Continental S.A., of Mr. F. J. Havenith as local resident director.

MR. ALEC M. HUGHES, general secretary of the Scientific Film Association, has been appointed visual aids officer of the British Assocation for the Advancement of Science.

C. A. PARSONS AND CO., Ltd., announces that Mr. G. M. Baker, director, who has for a number of years been chief mechanical engineer, has now been appointed general manager.

THE BRITISH TRANSPORT COMMISSION has announced that Mr. E. S. Cox has been appointed assistant chief mechanical engineer, British Railways' Central Staff, mechanical engineering department.

THE MINISTRY OF TRANSPORT AND CIVIL AVIATION has asked Mr. Airey Neave to act as chairman of a committee to be known as the Standing Joint Committee on Private and Club Flying and Gliding.

THE BRITISH ALUMINIUM COMPANY, Ltd., has announced that Mr. A. W. Killeen has been appointed manager, Leeds branch office, in succession to Mr. A. E. Heeley. He will take up his duties on November 1.

MR. T. A. G. MADDEN, M.I.Mech.E., M.I.E.E., has been appointed production, inspection and test engineer of the Central Electricity Generating Board. Mr. R. Farrall, M.I.E.E., has been appointed services engineer.

THE COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH announces that responsibility for the research programme of the Torry Research Station at Aberdeen will be vested in a steering committee. The committee will consist of Dr. B. K. Blount (chairman), Mr. G. C. Wilson, Dr. D. Traill, the director of the Torry Research Station, and Mr. H. Wooldridge.

THE SOUTH WESTERN ELECTRICITY BOARD announces that Mr. George W. Richards, A.I.E.E., has been appointed adviser to the Board's Bristol and Somerset groups of districts, and at the same time, manager of the Bristol districts. Mr. E. A. Newburn, M.I.E.E., has been appointed adviser to the Devon and Cornwall groups, and at the same time manager of the Plymouth district.

LONDON TRANSPORT has announced the following staff changes in the department of the chief electrical engineer: Mr. W. Ward, M.Inst.F., generating station superintendent (Greenwich) has been appointed generating station superintendent (Lots Road). Mr. G. F. Withers, M.Inst.F., generating station superintendent (Neasden) has been appointed generating station superintendent (Greenwich); and Mr. E. Hibbett, M.Inst.F., assistant generating station superintendent (Lots Road) has been appointed generating station superintendent (Neasden) with the rank of principal executive assistant.

A. REYROLLE AND CO., Ltd., has announced that Sir Claude D. Gibb, F.R.S., has decided to relinquish the chairmanship but retains his seat on the board of directors. Mr. H. H. Mullens, M.I.E.E., has succeeded him as chairman. Mr. C. A. Stephens has resigned his directorships of the Parolle Electrical Plant Company, Ltd., the British Short-Circuit Testing Station, Ltd., A Reyrolle and Co. (S.A.) (Pty.), Ltd., and A. Reyrolle and Co. (Rhodesia), Ltd. He remains a director of A. Reyrolle and Co., Ltd., J. H. Holmes and Co., Ltd., and Ets Merlin and Gerin, of Grenoble, France. Mr. J. Bennett joins the board of the Parolle Electrical Plant Company, Ltd., and Mr. W. G. Martin, the boards of A. Reyrolle and Co. (S.A.) (Pty.), Ltd., and A. Reyrolle and Co. (Rhodesia), Ltd.

ENGLISH STEEL CORPORATION, Ltd., has announced the following appointments to the boards of its operating companies:—English Steel Forge and Engineering Corporation, Ltd., Mr. W. H. Stratford, F.I.M., superintendent, steel melting; Mr. R. W. Brocklehurst, M.I.Prod.E., superintendent, heavy forge production. English Steel Rolling Mills Corporation, Ltd., Mr. P. Turrell, who will also hold the office of assistant managing director. English Steel Castings Corporation, Ltd., Mr. L. R. Evans, M.I.Mech.E., M.I.Prod.E., superintendent, foundries, and English Steel Spring Corporation, Ltd., Mr. R. Fielding, M.I.Prod.E., superintendent, spring production.

Business Announcements

SANDERS AND FORSTER, Ltd., 3, Buckingham Palace Gardens, London, S.W.1, has established an overseas office in Accra, Ghana.

KEELAVITE ROTARY PUMPS AND MOTORS, Ltd., announces that the name of the company has been changed to Keelavite Hydraulics, Ltd.

H. V. SMITH AND CO., Ltd., of London and Edinburgh, has become a member of the Natural Asphalte Mine-Owners and Manufacturers Council.

GRESHAM DEVELOPMENTS, Ltd., has moved to Thurlestone House, Uxbridge Road, Hampton Hill, Middlesex (telephone, Molesey 4540, 6211 and 3059).

THE AEROGRAPH COMPANY, Ltd., 47, Holborn Viaduct, London, E.C.1, states that its name has been changed to the Aerograph-De Vilbiss Company, Ltd.

BMW TRIEBWERKBAU, G.M.B.H., of Munich, has purchased an option to build the Bristol "Orpheus" lightweight turbojet engine under licence in Germany.

OTTERMILL SWITCHGEAR, Ltd., announces that extensions to its factory at Ottery St. Mary, Devon, were officially opened last Friday by Mr. Robert Matthew, M.P.

MR. J. P. CRAIG, sales director of Rotary Hoes, Ltd., West Horndon, Essex, is making a sales promotion tour of New Zealand, Australia, South and East Africa and the Rhodesias.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., has announced the retirement of Mr. John Taylor, deputy works manager, Leigh Works, after almost fifty-one years' service with the company.

MR. GAVIN C. PATERSON, director of Paterson Hughes Engineering Company, Ltd., is to leave for South Africa on November 7. He will visit Johannesburg, Durban and Cape Town and will return to England via Nairobi.

THE SOLARTRON ELECTRONIC GROUP, Ltd., Thames Ditton, Surrey, announces that the office of its German subsidiary company Solartron, G.m.b.H., is now at Bayerstrasse 13, Munchen, Germany (telephone, Munchen 595109).

MR. G. E. SAVORY, sales director, and Mr. D. H. Marlow, export sales manager, Ruston-Bucyrus, Ltd., Excavator Works, Lincoln, are visiting the United States, New Zealand, Australia and Singapore. They will return at the end of November.

MARCONI'S WIRELESS TELEGRAPH COMPANY, Ltd., states that agreement has been reached with Jugoimport, a Yugoslavian import agency, for the manufacture in Yugoslavia of Marconi's sub-miniature automatic direction finders, type AD 722.

THOMAS MARSHALL AND CO. (LOXLEY), Ltd., Storrs Bridge Works, Loxley, near Sheffield, has acquired the half-interest in Carblox, Ltd., previously held by the Morgan Crucible Company, Ltd. Carblox, Ltd., is now a wholly-owned subsidiary of Thomas Marshall and Co.

DEWHURST AND PARTNER, Ltd., Inverness Works, Hounslow, announces that it has now established a Canadian subsidiary company, Dupar (Canada), Ltd., Kitchener, Ontario. The company will be half-owned by Dewhurst and Partner and half by Dominion Electrohome Industries, Ltd., of Canada.

BOOKER BROTHERS, MCCONNELL AND CO., Ltd., states that Bookers Engineering Holdings, Ltd., has purchased 90 per cent of the issued share capital of Sigmund Pumps, Ltd. Mr. Miroslav Sigmund, managing director of Sigmund Pumps, Ltd., retains a 10 per cent interest in the company and remains managing director.

SIMMS MOTOR UNITS, Ltd., states that it has made the following appointments: De Witteleir and Keppens, S.P.R.L., 641/645, Chaussee de Waterloo, Brussels, 6, has been appointed central distributor for Belgium; in Luxembourg, Ateliers Nic. Georges, 194, Route de Thionville, Luxembourg, has been appointed central distributor; and Compagnie Generale, 13, Rue Brederode, Brussels, has been appointed central distributor for the Belgian Congo and Ruanda-Urundi.

Contracts

NATIONAL FREE PISTON POWER, Ltd., a subsidiary of the Hawker Siddeley Group, has been awarded a contract by the Iraq Petroleum Company, Ltd., for a 3000 h.p. free-piston gasifier turbo-pumping unit for erection on its pipeline in Syria. The machinery will comprise four 1000 h.p. GS.34 free-piston gasifiers and one series 300 expansion gas turbine manufactured by Brush Electrical Engineering Company, Ltd., which will drive a Mather and Platt Plurovane pump. The free-piston gasifiers will be able to run on the crude oil being pumped through the pipeline. The contract also covers the design and supply of all auxiliary equipment. The approximate value of the contract is £150,000.

WORKINGTON IRON AND STEEL COMPANY (a branch of the United Steel Companies, Ltd.) has placed an order with Lurgi Gesselschaft für Chemie und Huttenwesen M.B.H., Frankfurt am Main, for a Lurgi-Frodingham circular sinter cooler of 94 square metres effective cooling area. This design of cooler was originally developed for the Seraphim and Apex plants of Appleby-Frodingham Steel Company, Scunthorpe, and employs only air suction as the cooling medium. The cooler is scheduled for delivery during the next eighteen months, and much of the work will be fabricated in England. The contract is valued at approximately £90,000 and was negotiated on behalf of Lurgi by D.M.M. (Machinery), Ltd., London.

THE BRITISH TRANSPORT COMMISSION states that orders have been placed for another 168 diesel multiple-unit train vehicles for the Western Region of British Railways, as part of the railway modernisation programme. Of these vehicles, 108 are for London suburban services from Paddington, fifteen will go to the Bristol-Taunton area, and forty-five are for services in Devon and Cornwall, west of Newton Abbot. The Pressed Steel Company, Ltd., Paisley, is to build 123 of the vehicles, and the remaining forty-five units are to be constructed by Birmingham Railway Carriage and Wagon Company, Ltd., Smethwick. All the 168 vehicles, comprising fifty-seven motor open second-class, fifty-seven motor open brake second-class, and fifty-four intermediate first and second-class composite trailer cars, are to be delivered in 1959. They will be of standard design, 63ft 6in in length.

E.M.I. ELECTRONICS, Ltd., has been awarded a contract by the Independent Television Authority for what, when completed, will be the tallest television aerial mast in the Commonwealth. The 1000ft mast will be situated at Mendlesham, Suffolk, and will carry I.T.V.'s East Anglia programme. The contract includes the supply and erection of the mast, special directional aerial system and feeders from the transmitter. The aerial Mesny system is of a special E.M.I. design not used before in this country. The mast will be triangular in section with sides 6ft 6in wide. The aerial system will comprise four bays, each 100ft long, and will radiate horizontally polarised signals. The unsymmetrical radiation pattern required from this station could not have been met adequately, it is stated, with an aerial of conventional design. The radiation system provides exceptionally high aerial gain, enabling a comparatively low input of 8kW from the transmitters to give an effective radiated power of 200kW in the desired directions. British Insulated Callender's Construction Company, Ltd., are acting as sub-contractors for the design, supply and installation of the aerial supporting mast, and the steelwork will be fabricated by Painter Brothers, Ltd., of Hereford.

Miscellanea

GOLDEN JUBILEE.—A luncheon was given on Friday of last week by the Benjamin Electric, Ltd., Tottenham, London, N.17, at Whitehall Court, to celebrate the company's golden jubilee. The first British company, which was formed in 1908 to exploit and market the inventions of the late R. B. Benjamin, has since its foundation specialised in the production of industrial lighting fittings. The company's first factory was in Rosebery Avenue, and its first and only move was in 1918 when it moved to its present address in Tottenham.

STEEL FACTORY AND WAREHOUSE.—A new factory for Sandvik Swedish Steels, Ltd., at Halesowen, Birmingham, was officially opened on October 15 by the Swedish Ambassador to Great Britain. The site on which this establishment has been built covers two-and-a-half acres and, in addition to extensive office and amenity accommodation, the new building includes a well-organised warehouse with an area of 23,000 square feet. Sandvik's first association with this country was made in 1875, when S. A. Edwards and Co., Ltd., of Birmingham, became the Sandvik agency. The present company, Sandvik Swedish Steels, Ltd., was formed in 1914.

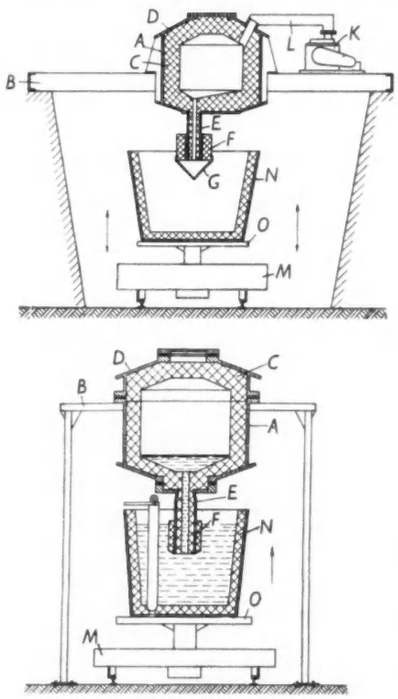
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

METALLURGY

801,518. January 8, 1957.—APPARATUS FOR DEGASIFYING MOLTEN METAL, The Dortmund-Horder Huttenunion Aktiengesellschaft, Reinische Strasse 173, Dortmund, Germany.

For degasifying iron and steel melts it is known to use large vacuum chambers which are generally arranged below the floor and into which the metal is cast into ladles or moulds from an intermediate vessel communicating with the chamber. Such installations, however, cannot be incorporated in the ordinary steel works and the invention is designed to overcome this disadvantage. Referring to the drawing, the apparatus consists of a fixed vacuum



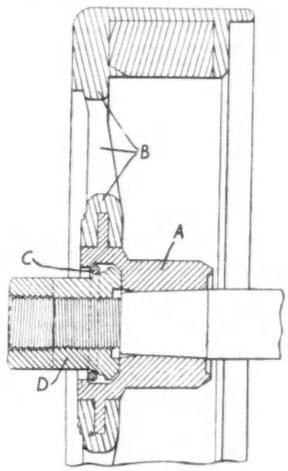
No. 801,518

vessel *A* which is mounted on a platform *B*. The vacuum vessel is lined with refractory brickwork *C* and is air-tight within a metal jacket *D*. The effective space within the vessel may be small. A pipe *E* lined on the inside with refractory brick opens into the bottom of the vessel *A* and its free end is surrounded by refractory brickwork *F* and a conical sheet metal body *G* is placed on the end to displace to the side any slag on the surface of the steel when the pipe is introduced into the melt. A pump *K* mounted on the platform is connected by a pipe *L* to the space within the vacuum vessel. The metal to be degasified is brought to the vacuum vessel on a truck *M*. A ladle *N* containing the melt stands on a platform *O* which can be raised and lowered by a hydraulic cylinder. After a vacuum has been established in the chamber of the vessel *A* the ladle *N* standing on the platform of the truck is raised, so that the pipe *E* is immersed in the molten steel. The conical body *G* shown in the upper view has meanwhile been melted and a part of the steel content of the ladle has been raised about 1·4m by the atmospheric pressure. The space inside the vacuum vessel is then filled to the extent indicated in the equipment shown in the lower drawing. After this part of the steel to be treated has been degasified the ladle *N* is lowered without altering the vacuum in the vessel and is brought into such a position that the metal, except for a portion remaining in the pipe *E*, then flows back into the melt remaining in the ladle *N*. The raising and lowering of the ladle and the inlet and outlet of a portion of the molten metal into and out of the ladle caused thereby is repeated until the entire contents of the ladle have been degasified to the desired extent. A diagram is also given in the specification showing the results of a practical experiment with the degasification process of the invention. It confirms the unexpected result that by a repeated introduction of only a part of the molten metal to be degasified into a vacuum vessel and the return of this part to the remainder of the metal in the ladle it is possible thoroughly to degasify the entire melt in a short time.—*September* 17, 1958.

POWER TRANSMISSION

801,822. March 26, 1956.—WHEEL MOUNTINGS, The Villiers Engineering Company, Ltd., Marston Road, Wolverhampton, Staffordshire, and Frank Anstey, of the company's address.

This invention relates to wheel mountings of the kind in which the wheel is provided or formed with a central boss having a tapered axial bore which co-operates with a tapered portion of a shaft and in which a nut screwing on to the end of the shaft is used to obtain and maintain a driving connection between the tapers. In a wheel mounting, according to the invention, a withdrawal abutment between the taper-bored boss in the hub portion of the wheel and the nut is afforded by a circlip, which encircles the



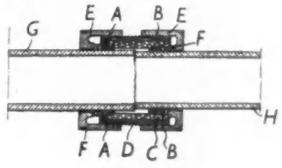
No. 801,822

nut and is expanded into an annular recess in the boss by a ramp on the nut as the latter is unscrewed from the shaft. The circlip is loosely imprisoned between the boss and the nut so that it does not interfere with the operation of the nut in tightening up the boss upon the shaft. By casting the taper-bored boss *A* in the hub of the wheel *B*, as shown in the drawing, and providing a withdrawal abutment in the form of a circlip *C* which is expanded into its operative position by the unscrewing of the nut *D*, the withdrawal load is taken directly by the boss.—*September* 24, 1958.

PIPE AND TUBE CONNECTIONS

802,286. March 2, 1956.—JOINT FOR TUBULAR MEMBERS, Louis Ulmer, 67, Boulevard Bessieres, Paris 17-eme, France.

The joint, as shown in the drawing, comprises two rings *A* and *B* having exterior surfaces of truncated conical shape. The rings are formed of helically coiled polytetrafluorethylene strip material. A third ring *C* of polytetrafluorethylene has its inner ends formed with surfaces of similar frusto-conical shape. A threaded metal sleeve *D* surrounds the ring *C*. Two tapped metal sleeves *E*, each have an internal collar *F*. To effect the connection between tubes *G* and *H*, there are threaded on to the end



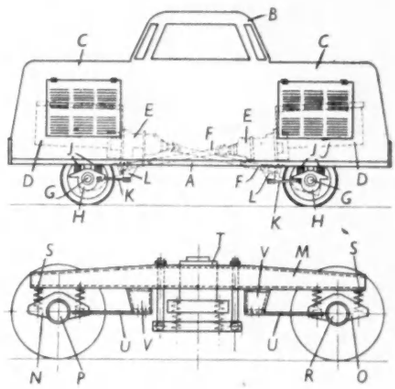
No. 802,286

of the tube *G*, for example, a sleeve *E*, the ring *A*, then the ring *C* with its sleeve *D*, and on to the end of the tube *H* the ring *B*, and finally a sleeve *E*. The sleeves *E* are screwed up, and in so doing the rings *A* and *B* are driven against the ring *C*. The frusto-conical faces of the rings react upon one another, and as the ring *C* cannot increase in diameter under pressure by the rings *A* and *B*, being embraced by the sleeve *D*, the resulting reaction is thus inwards and tightness of the rings on the tubular members is ensured. The helical strip form given to the rings increases their resilience, and if care is taken to make the direction of the helix opposite to that of the threads on the sleeve *E* which is to drive it, the clamping of the rings *A* and *B* is still further heightened.—*October* 1, 1958.

RAILWAY ENGINEERING

801,451. April 9, 1956.—WHEEL SUSPENSION MEANS FOR RAIL VEHICLES, The MaK, Maschinenbau Kiel Aktiengesellschaft 3, Falkensteinerstrasse, Kiel-Friedrichsort, Germany.

The invention relates to wheel suspension means for rail vehicles, particularly diesel locomotives, having a rigid bogie frame and axles carried in axle boxes on the frame. Its object is to provide a simple wheel suspension means. The drawing shows a



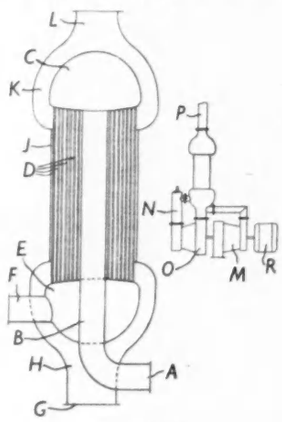
No. 801,451

diesel locomotive comprising a frame *A* which carries a body including a driver's cab *B* and front and rear portions *C* accommodating the driving engines. The drive from the engines is transmitted through gearings *E* and cardan shafts *F* to individual wheel sets *G* having axle boxes *H* resiliently supporting the frame in a vertical direction by means of soft springs *J*. An unhinged guide rod *K* is secured to one side of each axle box, and connected to a block *L* fixed to the frame. By means of the guide rods *K* each axle box *H* is rigidly connected with its block *L* in a horizontal direction. The lower view shows a bogie frame *M* provided on each of its longitudinal sides with axle boxes *N* and *O* for axles *P* and *R* the axle boxes resiliently supporting the frame *M* in a vertical direction by means of soft springs *S*. A vertically extending pivot *T* is mounted at the centre of the bogie. Elastic guide rods *U* are tightly clamped on the axle boxes *N* and *O* and are secured at their ends facing each other to blocks *V* for torsional and bending resistance and are adjustably mounted on the bogie frame *M*. The axle guide rods *U* consist substantially of plain leaf springs, and serve for taking up the longitudinal and lateral forces, and ensure support in horizontal directions and in both planes.—*September* 17, 1958.

GAS TURBINES

802,166. September 12, 1955.—COUNTER-FLOW HEAT EXCHANGERS FOR GAS TURBINES AND GAS TURBINE INSTALLATIONS, Henschel and Sohn G.m.b.H., 2, Henschelstrasse, Kassel, Germany.

The invention relates to counter-flow heat exchangers for gas turbines and to a gas turbine installation incorporating the same. In the drawing, the larger view shows the heat exchanger in longitudinal section and the smaller view the arrangement of the heat exchanger on a single shaft gas turbine plant. The air coming from a compressor enters the heat



No. 802,166

exchanger at inlet connection *A* and flows through a central tube *B* to the upper air collecting chamber *C*. The air passes from here through the numerous small tubes *D*, which bring about the heat exchange, into the lower air collecting chamber *E*. The now pre-heated air passes through the outlet pipe *F* into the combustion chamber. The exhaust gases issuing from the turbine arrive at the outlet connection pipe *G* in the lower exhaust gas chamber *H* which envelops the air collecting chamber *E*, then flow around the small tubes *D* in the cylindrical portion *J* in counter-flow and are collected in the pear-shaped exhaust gas chamber *K*, which envelops the chamber *C*. The exhaust gases leave the heat exchanger through the connection *L*. The heat exchanger is located vertically above the gas turbine outlet connection pipe *G* and the inlet connection *A* from the compressor to the heat exchanger and the outlet pipe *F* for the pre-heated air from the heat exchanger to the combustion chamber extend at right angles to the vertical axis of the heat exchanger. As shown, a compressor *M* sucks in air, compresses it, and forces it through a conduit to the heat exchanger. The air heated in the heat exchanger passes through a conduit to a combustion chamber *N* into which fuel is sprayed by injection nozzles. The combustion gases obtained pass into an inlet casing of a turbine *O*. The combustion chamber is located vertically above the inlet casing. After expansion the gases leave the turbine through an outlet housing and flow through the heat exchanger, in which they give up the bulk of their inherent heat to the compressed air. The combustion gases reach the atmosphere through an exhaust gas conduit *P*. Apart from the compressor *M*, the turbine also drives an electric current generator *R*.—*October* 1, 1958.

Launches and Trial Trips

CONSTANCE BOWATER, pulpwood carrier; built by the Caledon Shipbuilding and Engineering Company, Ltd., for the Bowater Steamship Company, Ltd.; length overall 325ft, breadth moulded 50ft, depth moulded 30ft, loaded summer draught 24ft 1in, deadweight 5458 tons; four holds, eight 6-ton derricks, electric winches, MacGregor steel hatch covers; Pleuger "Active" rudder; three 180kW diesel-driven generators; Denny-Sulzer "6.SD.60 "two-cycle, single-acting, six-cylinder diesel engine, 2700 b.h.p. Trial, August 26.

NORTH COUNTESS, cargo ship; built by the Blythswood Shipbuilding Company, Ltd., for Panconquista Compania Naviera S.A., Panama; length 485ft, breadth 67ft 6in, depth 41ft 10in, deadweight 15,200 tons on closed shelter deck, draught 31ft 0¼in; six holds, one 50-ton, one 25-ton, and twelve 10-ton derricks, electric deck machinery; three 300kW diesel-driven generators; trial speed 17 knots; Hawthorn-Doxford opposed-piston, diaphragm oil engine, arranged to burn heavy fuel, 7200 b.h.p. Trial, August 27.

Catalogues and Brochures

ENGLISH STEEL CORPORATION, Ltd., River Don Works, Sheffield, 9.—Illustrated booklet containing technical information on the design, application and manufacture of torsion bars.

BROOM AND WADE, Ltd., High Wycombe.—Publication No. 442TE, giving details of a lightweight medium-duty concrete breaker with an air consumption below 50 cubic feet per minute.

CARTER GEARS, Ltd., Thornbury Road, Bradford, 3, Yorkshire.—Leaflet No. DFC/2, giving details and dimensions of the hydraulic relay speed control for "F" type hydraulic infinitely variable speed gears.

R. B. PULLIN AND CO., Ltd., Phœnix Works, Great West Road, Brentford, Middlesex.—Leaflet describing servo components and instrument motors—representative Pullin "building blocks" for instrument and systems design.

R. H. COLE (OVERSEAS), Ltd., 2, Caxton Street, Westminster, London, S.W.1.—Leaflets giving technical details of the small selenium rectifiers made by Siemens and Halskeaktien-gesellschaft, for which R. H. Cole (Overseas), Ltd., is the sole U.K. agent.

THE MIDLAND TAR DISTILLERS, Ltd., Oldbury, Birmingham.—Publication entitled "The Use of Teramin Inhibitor for the Control of Corrosion Caused by Flue Gases," describing the problem of flue gas corrosion when burning sulphur-bearing fuels and the inhibition of such corrosion by metal passivation using Teramin bases.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., Trafford Park, Manchester, 17.—Publication entitled "Electric Motors and Associated Equipment for the Oil and Chemical Industries." The book, which contains 220 pages, is divided into three sections, flameproof equipment, general information and non-flameproof equipment. The book deals mainly with electric motors.

DEMAG AKTIENGESELLSCHAFT, Duisburg, Wolfgang-Reuter-Platz, Postfach 2 und 12.—Technical manual entitled "Industrial Equipment," containing a comprehensive survey of Demag's and its subsidiaries' and affiliates' manufacturing programmes. Photographs are used to illustrate special design features and to show equipment in operation. The book has nearly 300 pages and includes descriptions of more than 1500 products.

IMPERIAL CHEMICAL INDUSTRIES, Ltd., Millbank, London, S.W.1.—Brochure describing the nuclear engineering products manufactured by the company. These include components requiring advanced fabrication techniques with long-established materials such as mild steel, aluminium and magnesium and a variety of wrought products in zirconium. Details are also given of development work on beryllium, niobium and vanadium. Data sheets have been included in the booklet giving the physical, mechanical and metallurgical properties of aluminium, beryllium, hafnium, magnesium, niobium, titanium, vanadium and zirconium.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Tues., Oct. 28.—EAST KENT BRANCH: County Hotel, Canterbury, Film Show, 8 p.m.

Wed., Oct. 29.—HALIFAX BRANCH: Crown Hotel, Horton Street, Halifax, A.S.E.E. Diploma Scheme Oral Examination, 7.45 p.m. ★S.W. LONDON BRANCH: Visit to B.B.C. Television Studios, Lime Grove, 2.30 p.m.

Fri., Oct. 31.—STOKE AND CREWE BRANCH: Royal Hotel, Crewe, "Electric Melting Furnaces," W. L. Harrison, 7.30 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

To-day, Oct. 24.—SCOTTISH SECTION: Department of Natural Philosophy, The University, Edinburgh, "Flight Evaluation of Airborne Electronic Equipment," N. G. Hinkley, 7 p.m.

Wed., Oct. 29.—LONDON SECTION: School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, "Computers and Ferro-eiectric Storage," M. Prutton, 6.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., Oct. 27.—LEICESTER CENTRE: Demonstration Theatre, East Midlands Electricity Board, Charles Street, Leicester, "Shop Lighting," J. R. Just, 7 p.m.

Fri., Oct. 31.—BIRMINGHAM CENTRE: Regent House, St. Philip's Place, Colmore Row, Birmingham, "Modern Trends in Industrial Lighting," J. B. Lancaster, 6 p.m.

INCORPORATED PLANT ENGINEERS

Mon., Oct. 27.—WEST AND EAST YORKSHIRE BRANCH: Fuel Department Lecture Theatre, New Building, The University, Leeds, "Atomic Energy," R. F. Jackson, 7.30 p.m.

Tues., Oct. 28.—SOUTH WALES BRANCH: South Wales Engineers' Institute, Park Place, Cardiff, "The Clean Air Act and Effluents," A. S. Minton, 7.30 p.m.

Thurs., Oct. 30.—SHEFFIELD AND DISTRICT BRANCH: Grand Hotel, Sheffield, "Planned Maintenance with Particular Reference to Breakdowns," O. L. Pollack, 7.30 p.m.

Fri., Oct. 31.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham, "Clean Air Act," 7.30 p.m.

Tues., Nov. 4.—GENERAL MEETING: Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, "Operational Research and the Plant Engineer," G. D. Jordan, 7 p.m.

INSTITUTE OF MARINE ENGINEERS

Tues., Oct. 28.—NORTH EAST COAST SECTION: Stephenson Building, King's College, Claremont Road, Newcastle upon Tyne, "Petroleum Refining," E. H. Wild, 4 p.m. ★LONDON SECTION: Memorial Building, 76, Mark Lane, London, E.C.3, "Some Recent Developments in Fiat Marine Engines," Dott. Ing. R. de Pieri, 5.30 p.m.

Thurs., Nov. 6.—University College, 70, Upper Merrion Street, Dublin, "Marine Machinery Breakdowns," J. H. Milton, 8 p.m.

INSTITUTE OF PETROLEUM

Mon., Nov. 3.—61, New Cavendish Street, London, W.1, "Some Problems of Petroleum Geology in Kuwait," A. F. Fox, 5.30 p.m.

INSTITUTE OF REFRIGERATION

Thurs., Nov. 6.—Institute of Marine Engineers, 76, Mark Lane, London, E.C.4, Presidential Address, Sir Rupert de la Bere, Bt., 5.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Mon., Oct. 27.—SCOTTISH CENTRE: North British Hotel, Princes Street, Edinburgh, "Research on the Testing and Performance of Commercial Vehicle Brakes," R. D. Lister, 7.30 p.m.

Mon., Nov. 3.—SCOTTISH CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "From the Laboratory to the Road," D. W. Bravey, 7.30 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Tues., Oct. 28.—NORTH WESTERN BRANCH: The Blossoms Hotel, Chester, "Continuous Manufacture of Copper Sulphate," F. G. Molyneux, 7 p.m.

INSTITUTION OF CIVIL ENGINEERS

To-day, Oct. 24.—Great George Street, Westminster, London, S.W.1, Graduates' and Students' Conversazione, 7.30 to 11.30 p.m.

Tues., Oct. 28.—Great George Street, Westminster, London, S.W.1, "The Flow of Water in Unlined, Lined, and Partly-lined Rock Tunnels," C. F. Colebrook, 5.30 p.m.

Thurs., Oct. 30.—N.W. ASSOCIATION: Queen Hotel, Chester, Address by the Chairman, J. P. Bamber, 7.30 p.m.

Tues., Nov. 4.—Great George Street, Westminster, London, S.W.1, Presidential Address, A. J. S. Pippard, 5.30 p.m.

Thurs., Nov. 6.—N.W. ASSOCIATION: Engineers' Club, Albert Square, Manchester, "Railway Electrification and Modernisation in the Manchester Area," A. Lloyd Owen, 6.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., Oct. 27.—RADIO AND TELECOMMUNICATION SECTION: Savoy Place, London, W.C.2, "Rating of Speech Links and Performance of Telephone Networks," J. Swaffield and D. L. Richards; "Assessment of Speech Communication Links," D. L. Richards and J. Swaffield, 5.30 p.m. ★MERSEY AND NORTH WALES CENTRE: Town Hall, Chester, "Recent Developments in X-ray and Electron Microscopy with some Applications to Radio and Electronics," W. C. Nixon and C. W. Oatley, 6.30 p.m. ★NORTH EAST CENTRE: Neville Hall, Westgate Road, Newcastle upon Tyne, "Operational Experience at Calder Hall," K. L. Stretch, 6.15 p.m. ★WESTERN UTILISATION GROUP: South Wales Institute of Engineers, Park Place, Cardiff, Section Chairman's Address, R. A. Marryat, 6 p.m.

Tues., Oct. 28.—MEASUREMENT AND CONTROL SECTION: Savoy Place, London, W.C.2, Discussion on "Electronic Control of Machine Tools," opened by D. T. N. Williamson, 5.30 p.m. ★LONDON GRADUATE AND STUDENT SECTION: Public Library, Chelmsford, Essex, Repeat of Chairman's Address, J. F. Outram, 7 p.m. ★NORTH EAST CENTRE: College of Further Education, Workington, "Operational Experience at Calder Hall," K. L. Stretch, 7 p.m. ★NORTH WEST MEASUREMENT AND CONTROL GROUP: Engineers' Club, Albert Square, Manchester, "Digital Computing Machines," T. Kilburn, 6.15 p.m.

Wed., Oct. 29.—SUPPLY SECTION: Savoy Place, London, W.C.2, "Art, Craft and Rampart," D. P. Sayers, 5.30 p.m. ★LONDON GRADUATE AND STUDENT SECTION: Visit to Marconi-Osram Valve Company, Ltd., Hammersmith, 2.30 p.m. ★SOUTH-WEST SCOTLAND SUB-CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, Sub-Centre Chairman's Address, W. Adam, 7 p.m.

Fri., Oct. 31.—SOUTHERN CENTRE: South Dorset Technical College, Weymouth, "Three Weeks in the U.S.S.R.," Sir Josiah Eccles, 6.30 p.m.

INSTITUTION OF ENGINEERING DESIGNERS

Mon., Nov. 3.—NORTH-EAST BRANCH: Northern Architectural Association Hall, 6, Higham Place, Newcastle upon Tyne, "Project for Power," film and talk on Steam Raising Plant, R. M. Wealleans, 7.15 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Fri., Oct. 31.—Morning visit to the Fraser and Chalmers Engineering Works of the General Electrical Company, Ltd., Erith, Kent, and afternoon visit to the foundries of J. Stone and Co. (Charlton), Ltd., Charlton.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Oct. 24.—1, Birdcage Walk, Westminster, London, S.W.1, Symposium on Engine Noise and Noise Suppression, arranged by the Internal Combustion Engine Group Committee, 4 p.m.

Sat., Oct. 25.—LONDON GRADUATE SECTION: Visit to the Tower Bridge, London, 3 p.m.

Mon., Oct. 27.—YORKSHIRE BRANCH: Institute of Technology, Bradford, "Turning with Ceramic and Sintered Oxide Tools," R. C. Brewer, 7 p.m.

Tues., Oct. 28.—1, Birdcage Walk, Westminster, London, S.W.1, Symposium on Aluminium Pressure Vessels (Registration Required), 2 p.m. ★NORTH-WEST BRANCH, LIVERPOOL PANEL: Liverpool Engineering Society, 24, Dale Street, Liverpool, "Application of Nuclear Power to Marine Propulsion," J. E. Richards, 6 p.m.

Wed., Oct. 29.—LUBRICATION GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, Discussion "Can Automotive Type Bearings be Applied More Generally in Engineering?" 6 p.m. ★SOUTHERN BRANCH: Technical College, Boundary Road, Farnborough, Hants, "The Bases of Measurement," H. Barrell, 7.30 p.m. ★EAST MIDLAND GRADUATE SECTION: College of Further Education, Greenclose Lane, Loughborough, "Air Starters for Gas Turbine Aero-Engines," J. R. F. McNair, 7.15 p.m. ★NORTH EAST GRADUATE SECTION: Vane Arms Hotel, Stockton, "Shield Cooling at Bradwell," J. S. Franklin, 7 p.m.

Fri., Oct. 31.—ORDINARY MEETING IN CONJUNCTION WITH THE APPLIED MECHANICS GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, "Estimation of Upper Bound Loads for Extrusion and Coining Operations," W. Johnson, "Theoretical Analysis of the Bending of Wide Plates of an Aluminium Alloy in the Plastic Range," J. M. Alexander, 6 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., Oct. 27.—MANCHESTER SECTION: College of Science and Technology, Sackville Street, Manchester, "Zeta," J. Blears, 7.15 p.m.

Wed., Oct. 29.—SHREWSBURY SECTION: Technical College, Abbey Foregate, Shrewsbury, "The Russian Machine Tool Industry," N. Stubbs, 7.30 p.m.

Sat., Nov. 1.—NEWCASTLE UPON TYNE GRADUATE SECTION: Visit to the North Eastern Marine Engineering Company, Ltd., Wallsend, 10 a.m.

Tues., Nov. 4.—LUTON SECTION: Town Hall, Luton, "Machine Tool Development in the U.S.S.R.," N. Stubbs, 7.30 p.m. ★LIVERPOOL GRADUATE SECTION: Radiant House, Bold Street, Liverpool, 1, "Servo Mechanisms," C. Pomfrett, 7.30 p.m.

INSTITUTION OF THE RUBBER INDUSTRY

Mon., Nov. 3.—NORTH EAST SECTION: Eldon Grill, Grey Street, Newcastle, "Costing Procedure in the Rubber Industry," F. F. Picken, 7 p.m. ★PRESTON SECTION: Bull and Royal Hotel, Church Street, Preston, "Recent Developments in High Impact P.V.C.," S. Mottram or D. A. Lever, 7.15 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

To-day, Oct. 24.—MIDLAND COUNTIES BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, Chairman's Address, B. C. Britton, 6.30 p.m.

Tues., Oct. 28.—LANCASHIRE AND CHESHIRE BRANCH: College of Science and Technology, Manchester, Chairman's Address, D. D. Matthews, 7.15 p.m.

Wed., Oct. 29.—LANCASHIRE AND CHESHIRE BRANCH: The University and College of Science and Technology, Manchester, Symposium on Structural Engineering.

Fri., Oct. 31.—MIDLAND COUNTIES GRADUATES' AND STUDENTS' SECTION: Exchange and Engineering Centre, Birmingham, "Future Trends in Structural Engineering," Ove Arup, 6.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Oct. 24.—INFORMAL MEETING: Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Progress in Fluid Couplings," J. W. Lee, 7 p.m.

Fri., Oct. 31.—INFORMAL MEETING: Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Gas Cleaning in Practice," W. T. Cosby, 7 p.m.

Wed., Nov. 5.—MIDLAND SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "Industrial Lighting," Mr. MacCarthy, 7 p.m.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Wed., Oct. 29.—STUDENT SECTION: Bolbec Hall, Newcastle upon Tyne, Chairman's Address, "The Marine Applications of Atomic Energy," P. A. Milne, 7 p.m.

Fri., Oct. 31.—Literary and Philosophical Society, Newcastle upon Tyne, "Nuclear Power for the Propulsion of Commercial Shipping," Sir John Cockcroft, 6.15 p.m.

PLASTICS INSTITUTE

Tues., Oct. 28.—Wellcome Building, 183-193, Euston Road, London, N.W.1, "Vinyl Chloride Polymers: their Design and Application," B. S. Dyer, 6.30 p.m.

REINFORCED CONCRETE ASSOCIATION

Thurs., Oct. 30.—WEST OF ENGLAND BRANCH: New School of Engineering, The University, Bristol, "Concrete Construction in the Soviet Union," L. J. Murdock, 6 p.m.

Mon., Nov. 3.—NORTH WEST BRANCH: College of Technology, Sackville Street, Manchester, "Prestressed Concrete Tanks," L. R. Creasy, 6.45 p.m.

SHEFFIELD SOCIETY OF ENGINEERS AND METALLURGISTS

Tues., Nov. 4.—The University, St. George's Square, Sheffield, "Furnace Design and Steel Making Techniques," C. Holden, 7.30 p.m.

SOCIETY OF ENGINEERS

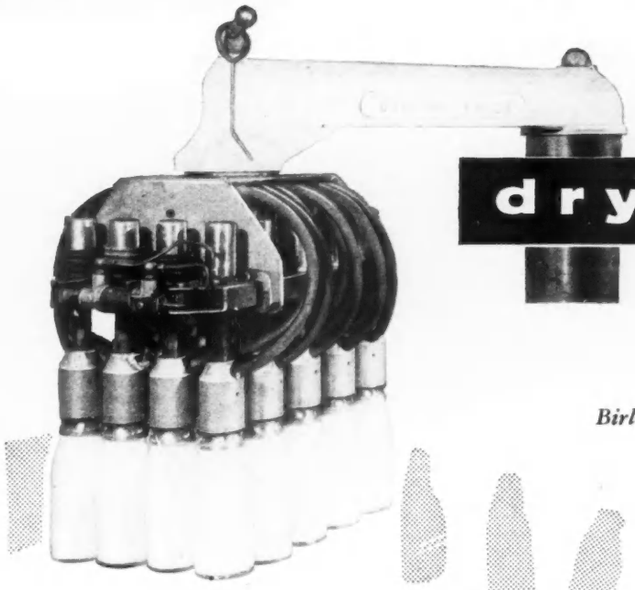
Mon., Nov. 3.—Geological Society, Burlington House, Piccadilly, London, W.1, "Hydrography," G. S. Ritchie, 5.30 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Tues., Oct. 28.—INFORMAL MEETING: Manson House, Portland Place, London, W.1, "Basic Measurements of Time and Frequency," L. Essen, 5.30 p.m.

UNIVERSITY OF LONDON

Tues., Oct. 28.—Royal College of Science, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7, "Some Automata of the Eighteenth Century," Heinz Zemanek, 5.30 p.m.

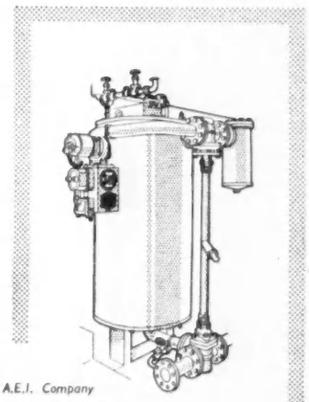


dry pneumatics

Water vapour is always present in compressed air, building up unseen corrosion, blockages and, finally, expensive maintenance problems.
Birlec Adsorbers banish water worries and problems dry up!

This milk bottling plant at Nottingham Co-operative Society is fed with DRY compressed air from a Birlec Adsorber.

No water in their pneumatics!

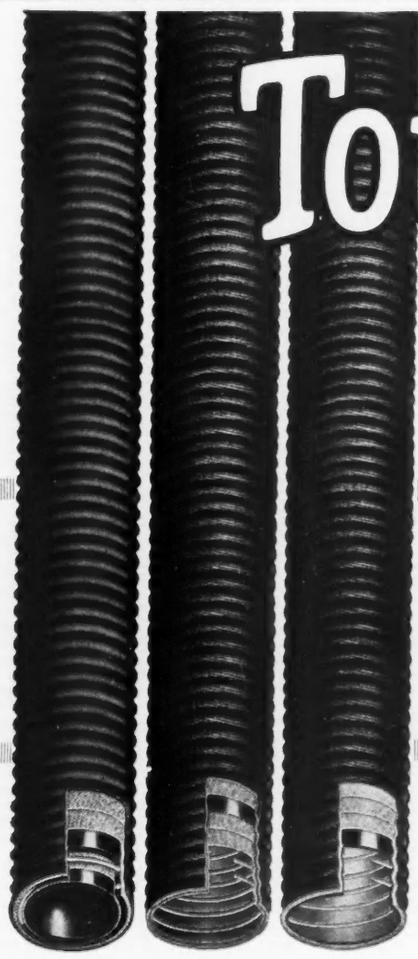


BIRLEC ADSORPTION DRYERS DRY AIR & GASES

Dryer Division of **BIRLEC LIMITED** An A.E.I. Company

ERDINGTON · BIRMINGHAM 24
LONDON · SHEFFIELD · GLASGOW · NEWCASTLE-ON-TYNE

SM/B3689



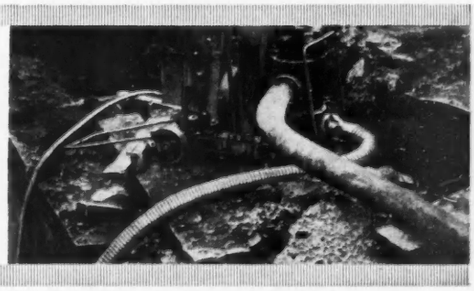
Tough

GOODYEAR HAND-BUILT HOSE for every suction job

Long service in exacting conditions has time and again proved the superiority of Goodyear Hand-Built Hose for suction and discharge duties whether it be water, chemicals, foods, beverages, sand or gravel. Skilfully designed and constructed, the hose has multiple plies of high-strength closely-woven fabric with a helix of round steel wire to provide reinforcement against collapse and crushing. Most types can be supplied in any length up to 60 feet.

Whatever the service, Goodyear Hand-Built Hose is first choice for tough, long-lasting, low-cost operation.

Goodyear Water Suction and Discharge Hose is manufactured in three types—with smooth-bore and fully embedded reinforcement for heavy duty service, especially when the water is corrosive, with rough bore for general service and with semi-embedded wire for heavy duty applications



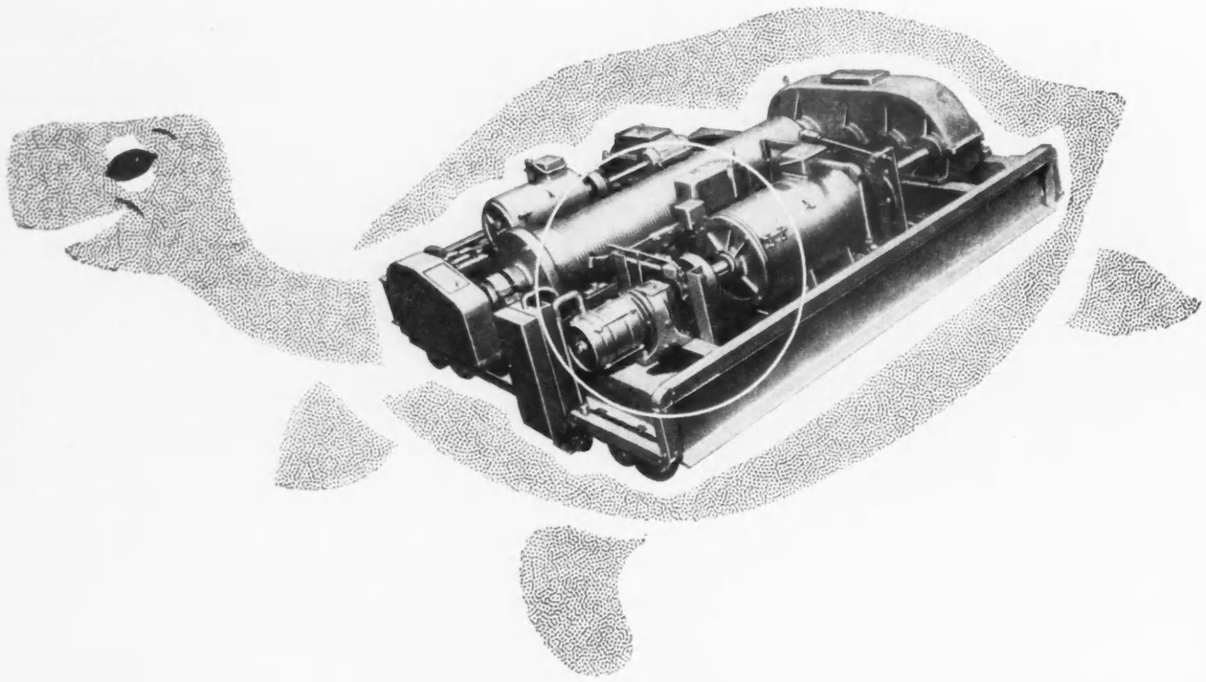
GOODYEAR

INDUSTRIAL RUBBER PRODUCTS

TRANSMISSION & CONVEYOR BELTING · V-BELTS · HOSE · FENDERS

THE GOODYEAR TYRE & RUBBER CO. (GB) LTD · INDUSTRIAL RUBBER PRODUCTS DIVISION · WOLVERHAMPTON

slowly but surely . . .



Slomax Creep-Speed Control

This system was developed to meet the need for a controlled creeping speed for all motions of cranes on A.C. supply where precise slow-speeds are required.

The success of this well-tried system, proved under arduous conditions, lies in its extreme simplicity.

The device is entirely automatic and fool-proof.

The main motor is not energised when the creeping speed is in operation.

The operating circuits being electrically inter-locked, it is impossible for the main motor and the Slomax motor to operate simultaneously.

Slomax control permits an unlimited ratio between creeping and normal speeds, and whilst ten to one is usual, a ratio of fifty to one is not uncommon for specialised duties.

A further advantage is that where precise creeping speeds are required for specialised operations, the Slomax control will ensure a predetermined creeping speed, irrespective of the load on the hook.

THE WHARTON CRANE & HOIST CO. LTD.

REDDISH STOCKPORT ENGLAND

Phone : Heaton Moor 2227. Grams : "Gallant, Manchester." Code : Western Union

LONDON: Lincoln House, 296/302 High Holborn W.C.I.	Phone: Chancery 7911.	Grams: Chancery 7911.
SCOTLAND: Fisher-Baxter & Co., 140 West George Street, Glasgow C.2.	Phone: Douglas 1061-2-3.	Grams: Fluorspar, Glasgow.
MIDLANDS: A. R. Holland & Son, 89 Cornwall Street, Birmingham 3.	Phone: Central 1457.	Grams: Central 1457, Birmingham.
SOUTH-WEST: R. C. Collins, 48 Westbourne Road, Penarth, Glamorgan.	Phone: Penarth 1527.	Grams: Penarth 1527.
NORTHERN COUNTIES: Fisher-Baxter & Co., 140 West George Street, Glasgow C. 2.	Phone: Douglas 1061-2-3.	Grams: Fluorspar, Glasgow.
NORTHERN IRELAND: General Engineering Products Ltd., 7/9 Great Patrick Street, Belfast.	Phone: Belfast 23743.	Grams: Belfast 23743.
EIRE or SOUTHERN IRELAND: Charles Nolan & Co., 2 Parker Hill, Lower Rathmines Road, Dublin.	Phone: Dublin 93510.	Grams: Dublin 93510.
CANADA: Marshall Equipment Co. Inc., P.O. Box 28, 61 Victoria Avenue, Dorval Station, P.Q.	Phone: Melrose 1-3528.	Grams: Marquipco, Montreal.

MAGNETIC
HANDLING
SEPARATION
TRANSMISSION
by

BOXMAG

LIFTING MAGNETS
CHUTES
CONVEYOR HEADS
SWEEPERS
OVERBAND SEPARATORS

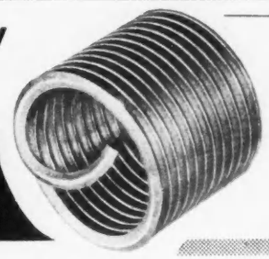
SUSPENSION MAGNETS
CLUTCHES
MAGNETIC PULLEYS
DRUMS
PERMANENT MAGNETS

ELECTROMAGNETS LTD.

TELEPHONE CENTRAL 539 Boxmag Works, Bond St., Birmingham, 19. TELEGRAMS BOXMAG B'HAM

Better than New
with a . . . .

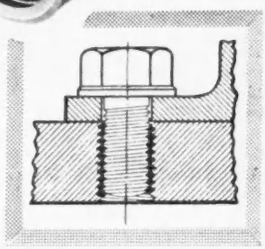
Cross



BRITISH WIRE THREAD INSERT

PRECISION MADE in CARBON STEEL for ALUMINIUM and MAGNESIUM.

We also make Stainless and Bronze for other applications.

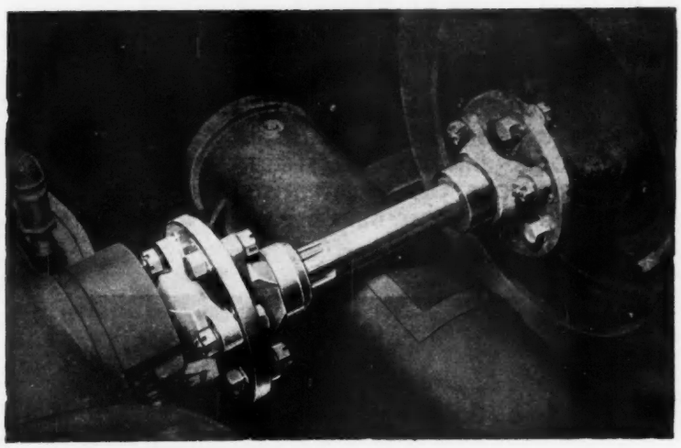


CROSS MANUFACTURING CO. (1938) LTD.

Tel: Combe Down 2355-8 **BATH, SOMERSET** *Grams: Circle, Bath*

Specialists in JET ENGINE LABYRINTHS, CIRCLIPS, SPRING WASHERS, SPRINGS, etc.

POWER TRANSMISSION—
through the medium of
FLEXIBLE
FABRIC
COUPLING
DISCS



★ Are easily assembled.
★ Give extreme torsional flexibility.
★ Absorb irregularities in load variations.
★ Axial and parallel misalignments are corrected.

ESTABLISHED 1895

HERMETIC RUBBER Co LTD

Hermetic Works, Ryland Street, BIRMINGHAM, 16

'Phone : EDGbaston 0983/4 Telegrams : "Hermetic Birmingham."

Men who work at
PRESSURE

know the value of
reliable and
accurate
VALVES

Automatic plate and disc valves are our particular concern. It's astonishing how many different versions of these vital components we have produced in the last seventy years. Our experience is unique—and is at your service.

Your valve problems are our business

THE
METALLIC VALVE
COMPANY LIMITED

117/125 BRIDGE ST., BIRKENHEAD, CHES. PHONE BIRKENHEAD 8961/2

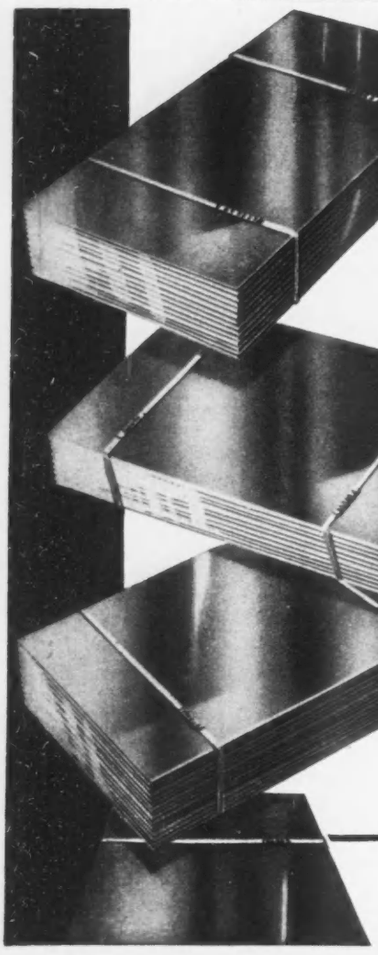
An important addition to the Ermeto range of Gate Valves

Introducing the ERMETO — NH Type 103 Gate Valve with the bolted bonnet now available from stock. This latest type augments the existing range of Gate Valves suitable for a wide variety of fluids and gases at pressures up to 2,000 lbs. p.s.i.

Details of all Ermeto Valves and Couplings will be sent on request

ERMETO **VALVES & COUPLINGS**

British Ermeto Corporation Ltd · Beacon Works · Hargrave Road · Maidenhead · Berks Telephone: Maidenhead 5100 (10 lines)



Ductile

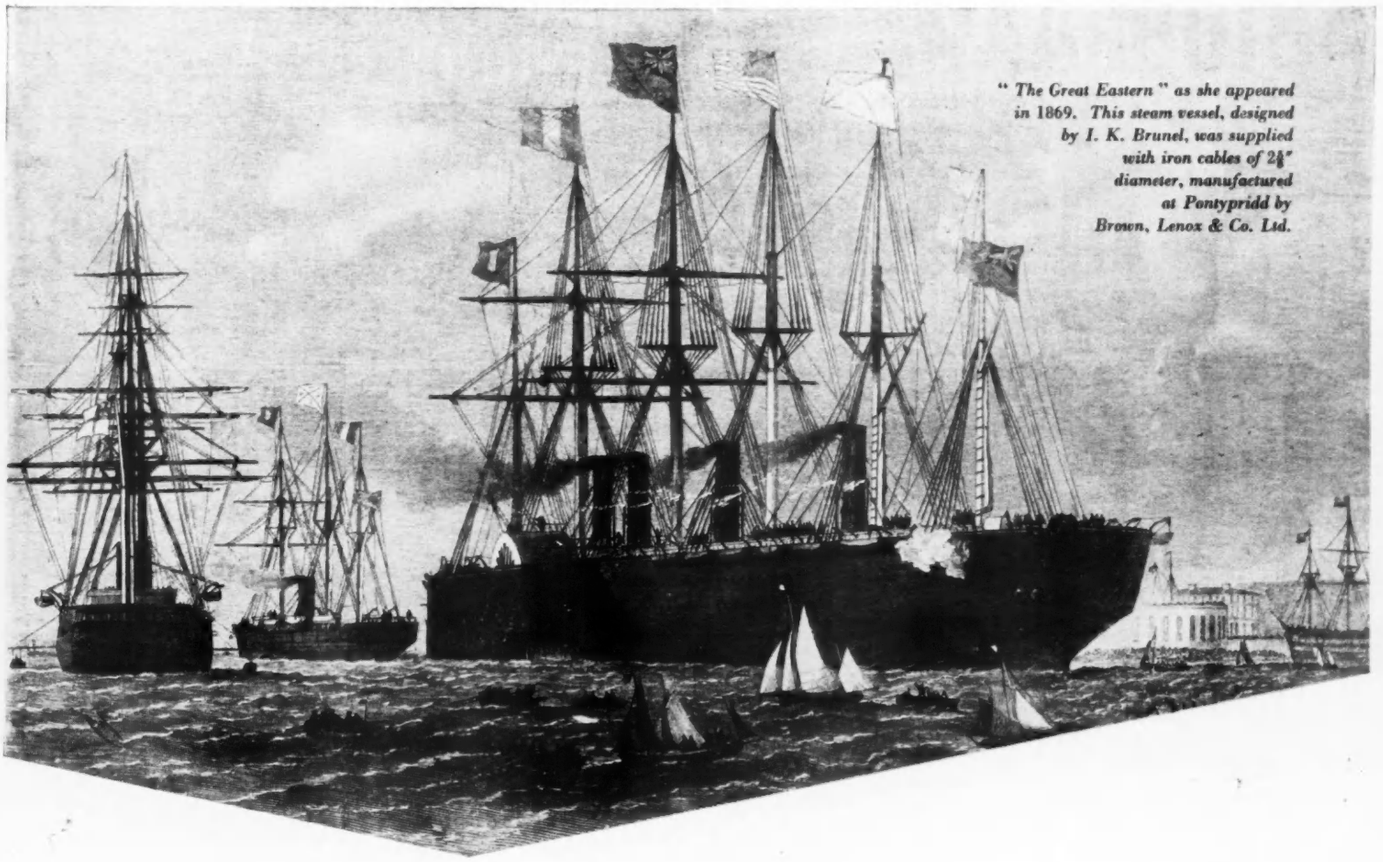
Steel Sheets

HOT ROLLED STRIP MILL SHEETS
HOT ROLLED STRIP MILL PICKLED & OILED SHEETS
COLD REDUCED BRIGHT STEEL SHEETS OILED IN GENERAL PURPOSE AND FULL FINISH GRADES
IN DRAWING AND EXTRA DEEP DRAWING QUALITY
SHEARING CAPACITY UP TO ⅛" THICK

Steel Company of Wales ACCREDITED SHEET STOCKHOLDER

Ductile SHEET STOCKISTS LTD

NEACHELLS LANE—WILLENHALL STAFFS *Telephone: WOLVERHAMPTON 32371*



" The Great Eastern " as she appeared in 1869. This steam vessel, designed by I. K. Brunel, was supplied with iron cables of 2⅛" diameter, manufactured at Pontypridd by Brown, Lenox & Co. Ltd.

From Napoleon to Elizabeth II . . .

The founder of this Company *invented* and manufactured the first chain cable ever to be used for the mooring of ships; this was in 1806.

From 1808 until 1916 the Company unbrokenly, year by year, was awarded the contract for the British Admiralty chain cable requirements.

Today, Brown, Lenox & Co. Ltd. is known all over the World as one of the leading firms specialising in the design of moorings—and in the manufacture of the components of which a mooring is made up.

The Company operates one of the very latest types of automatic machines for the production of ***high tensile electric flash butt welded steel chain cable.*** *Chain cable is made* ***in sizes up to those suitable for mooring the largest vessels afloat.***

The following publications are available:

- **MOORINGS AND BUOYS** (32 Pages)
- **BLeCO MOORING AND SHIPS CHAIN CABLE** (8 Pages)
- **BLāCO HIGH TENSILE STEEL CHAIN CABLE** (Leaflet)
- **SHIPS CHAINS, ANCHORS & ANCILLARY GEAR** (16 Pages)

Copies of any, or all, of these publications will be sent free of charge, and postage paid.

Brown Lenox

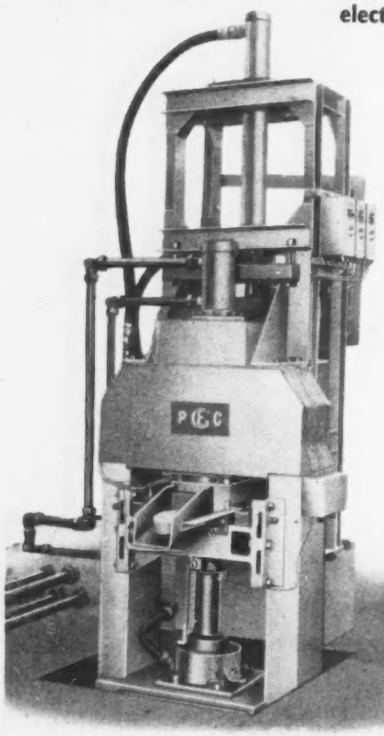
Illustration by courtesy of the Trustees of the National Maritime Museum.

An announcement by the Marine Division of

BROWN, LENOX & COMPANY LIMITED
Associated Company: Brown, Lenox & Co. (London) Ltd., Millwall, E.14
PONTYPRIDD GLAMORGAN

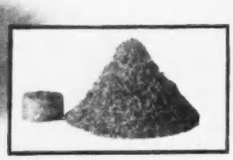
AUTOBRAAV

The Autobraav is an electro-hydraulic fully automatic briquetting machine for pressing a wide variety of materials.



- ★ Fully automatic in operation.
- ★ High output.
- ★ High density briquettes reduce volatisation during re-melting.
- ★ Models actually operating under working conditions.
- ★ Send us your enquiries and problems.

Illustration shows turnings before pressing — 275 cubic inches and after pressing 40 cubic inches.

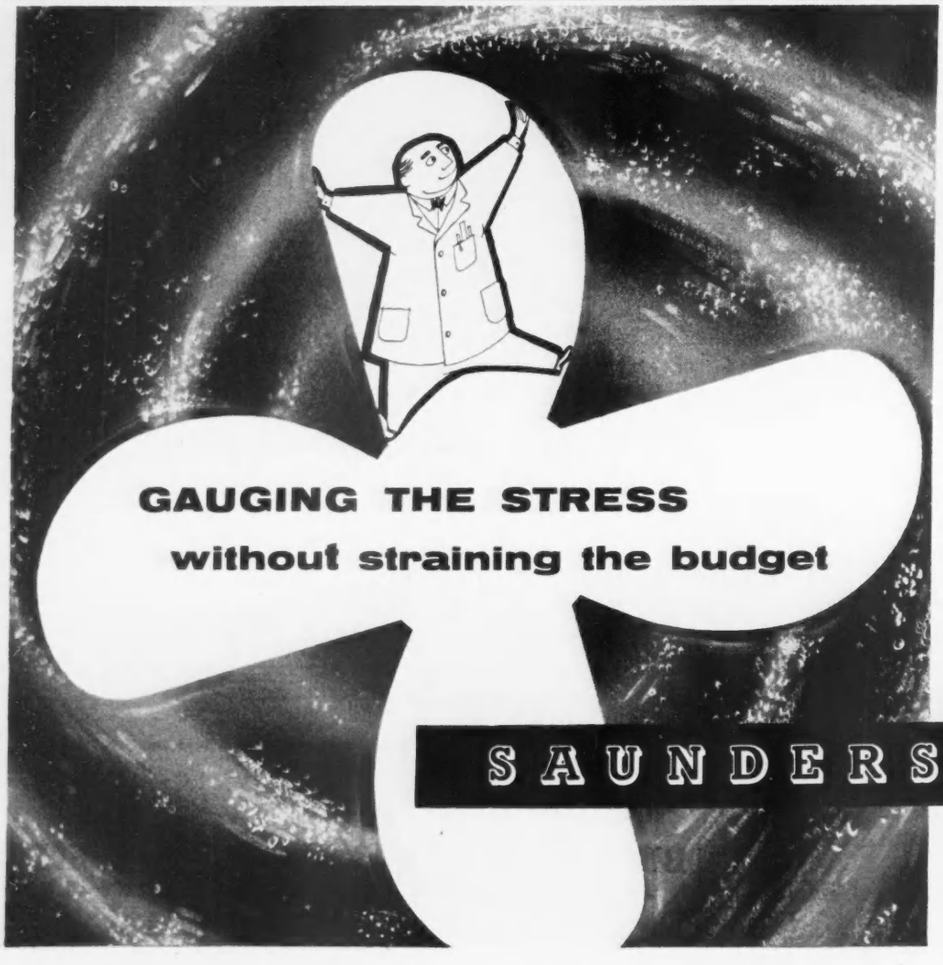


PLANTERS ENGINEERING CO. LTD.

14 Craven Road, London, W.2. Tel.: AMBassador 3295/6. Cables: Veloces. Padd. London.
5863 Associated with Entwisle & Gass Ltd.

JENKS BROTHERS LIMITED,

BRITOOL WORKS,
BUSHBURY, WOLVERHAMPTON



*

Saunders-Roe Foil Strain Gauges find the facts precisely about any kind of mechanical stress or strain—moving or static, large or small, normal or abnormal. They are inexpensive and simple to install. New applications in which they give essential and often unique service are constantly being found.

For instance, Foil Strain gauges have:

- *enabled the Trans Antarctic Expedition to determine the towing force and sledging efficiency of 'Snocat' tractors and to measure the magnitude of the co-efficient of friction of snow.*
- *located for the Timber Development Association the transient high bending stresses of wood and plastic archery bows.*
- *measured for the Admiralty the stresses in the propellers of sea-going ships.*

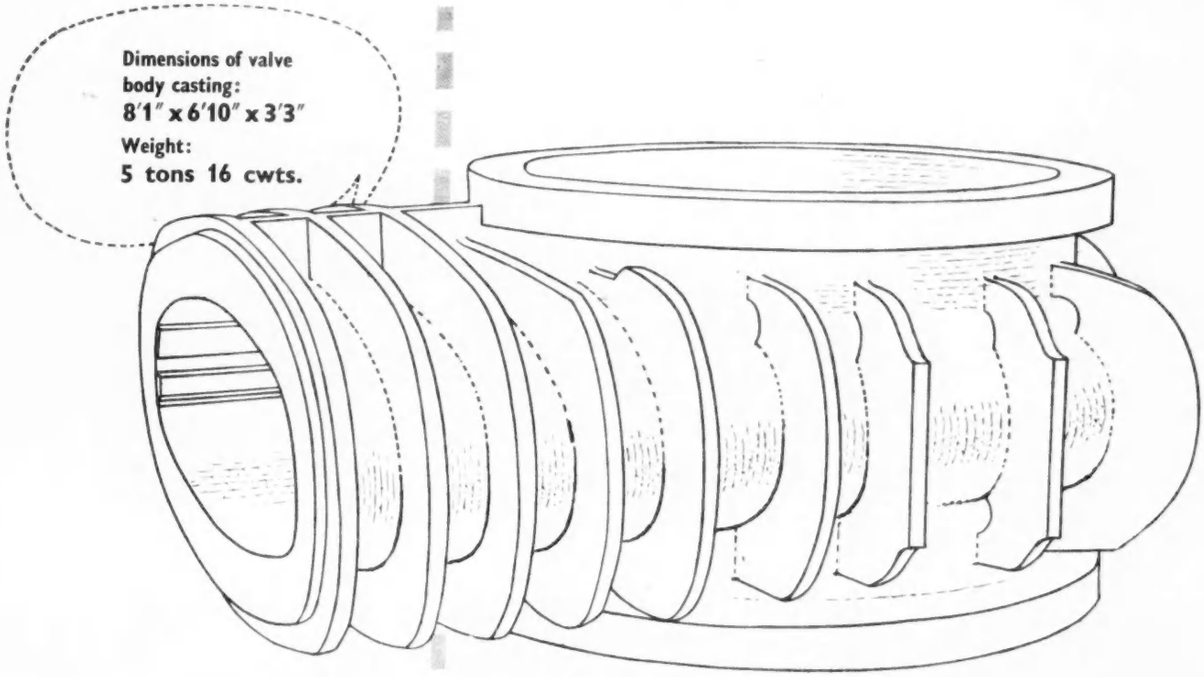
Foil Strain Gauges can mean new facts acquired at little cost. Whatever you make, whatever you build, Foil Strain Gauges can help you. We shall be pleased to send you technical data sheets and other information about the range of these and other Saunders-Roe electronic products.

If required our comprehensive service is ready to tackle your problem for you and provide you with the results you need.

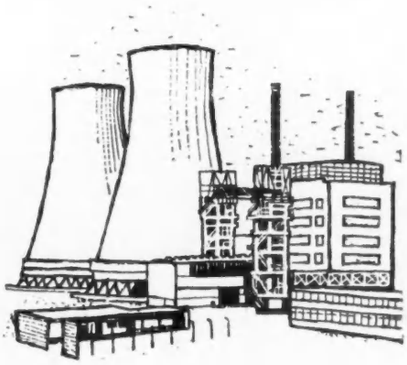
SAUNDERS — ROE

ELECTRONICS DIVISION

Saunders-Roe Ltd., Electronics Division, East Cowes, Isle of Wight.



Jarrow Castings for Nuclear Power Plant



In the cooling system for the reactor at Calder Hall, the 54" valves are working at the unusually high temperature of 700°F. One of them is shown here with a body of J.M.I. cast steel. Before installation on this vital job, the casting was subjected to the most exacting hydrostatic, operating and tightness tests at full working pressure.

Jarrow Metal Industries Ltd.

WESTERN ROAD, JARROW

IN ASSOCIATION WITH ARMSTRONG WHITWORTH (METAL INDUSTRIES) LTD., CLOSE WORKS, GATESHEAD 8, CO. DURHAM.

253/58

FORGING THE LINK

The Metrovick Atomic Hydrogen method of welding gives complete protection for the weld metal in the fluid state making the process eminently suitable for welding chain where the weld metal must have the same strength and quality as the parent metal.

This desirable feature of Atomic Hydrogen welding, together with the advantage of high welding speed—due to the high arc temperature—can be usefully applied where sound ductile welds are required in mild steel, stainless steel, alloy steel and some non-ferrous metals, e.g. building up surfaces, repairing drills, depositing tool steel cutting edges on mild steel punches and dies, seam welds on fire extinguishers and similar containers liable to rough handling.

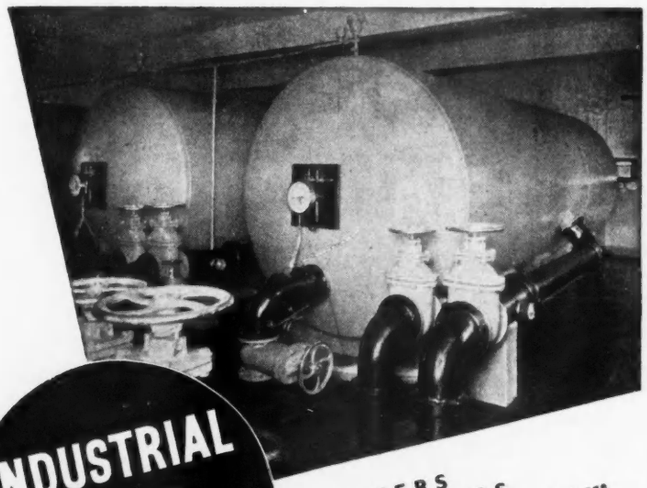
Photograph by courtesy of Messrs. Watson & McLean Ltd.

METROPOLITAN-VICKERS
ELECTRICAL CO LTD · TRAFFORD PARK · MANCHESTER, 17

An A.E.I. Company

METROVICK Equipment for More Efficient Welding

L/W 705



INDUSTRIAL WATER TREATMENT

FILTERS
SOFTENERS
Lime-Soda and Base-Exchange
BOILER FEED CONDITIONING EQUIPMENT
CHEMICAL PROPORTIONING APPARATUS
(Chemical Pumps, Gravity Solution Dosers, Dry Feeders)

UNITED FILTERS & ENGINEERING LTD
LONDON S.W.15
Phone: PUTney 4441 (3 lines). Grams: Unifilters, Put. London

AIA

MOBILE GANTRY
1-2-3 tons capacity .. or to your requirements.

'Just the job' Gantry with either an Electric or Chain Block. Loads weighing up to 3 tons handled safely, easily and quickly.
Heights up to 18' maximum.
Highly suitable for EXPORT.

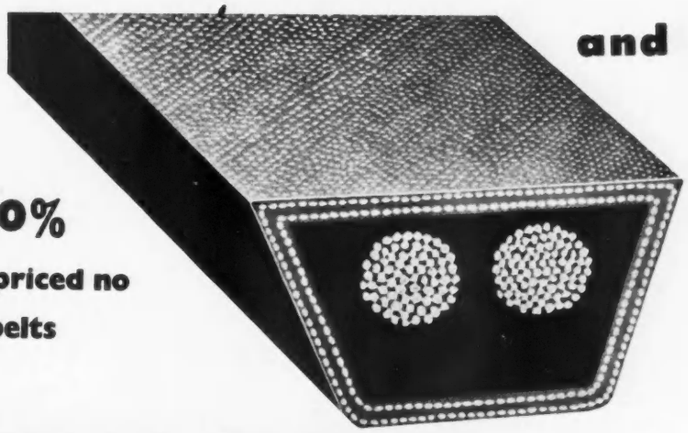
Illustration shows simple dismantling and compactness for storage or shipment.

Please send for fully descriptive literature to Dept. E.

AIA EQUIPMENT
ALLEN & Co (ENGINEERS) LTD.
SPENCER BRIDGE WORKS
NORTHAMPTON
*Phone: 5971/4

There's a *Big Difference*

between this



and any other V-belt

LAST 20 to 50% LONGER... Yet priced no higher than ordinary belts

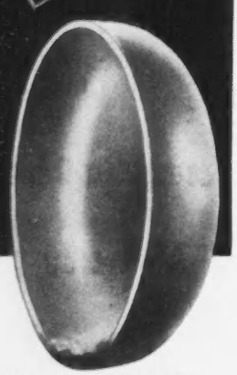
TEXROPE
Grommet V-Belts

ALL BRITISH
TEXROPE GROMMET V-BELT DRIVES
MANUFACTURED AND SOLD ONLY BY

FRANK WIGGLESWORTH & CO LTD
SHIPLEY YORKSHIRE
'Phone : SHIPLEY 53141
Grams : CLUTCH, SHIPLEY

ABBOTT of NEWARK

Specialists in the Manufacture of Dished Ends



DISHED & FLANGED VESSEL ENDS
BOILERS · LOCO FIREBOXES and all PRESSURE VESSELS
Riveted or Welded

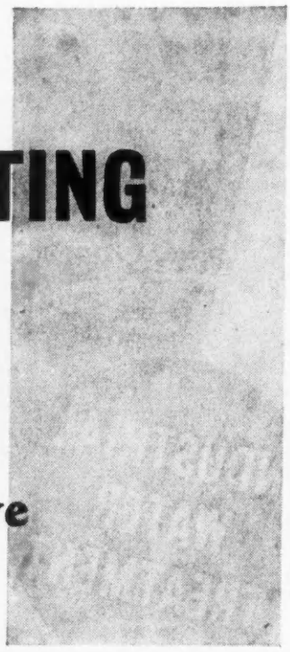
•

WELDED and FLANGED WORK A SPECIALITY

ABBOTT & Co (NEWARK) LTD.
NEWARK BOILER WORKS.
NEWARK·NOTTS·ENGLAND
Telephone: Newark 34.

PROFILE CUTTING

- **Large capacity**
- **Comprehensive stocks of plate**
- **Keen competitive prices**



CONTACT

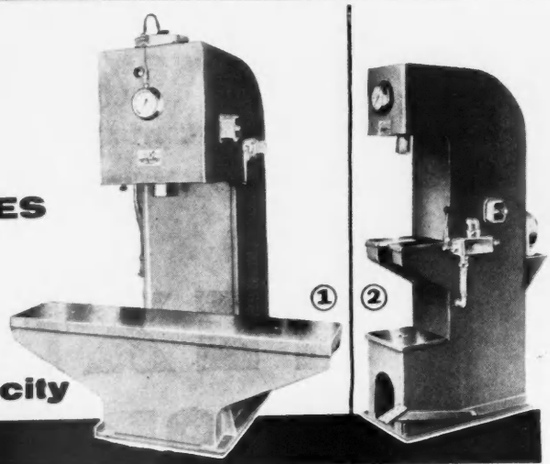
COX AND DANKS LIMITED

BIRMINGHAM	MANCHESTER	SHEFFIELD	LONDON
Scapa Works Langley Green Oldbury, Birmingham	Frederick Road Pendleton Salford 6	Scapa Works Wadsley Bridge Sheffield 6	Scapa House Park Royal Road London N.W.10
Tel: Broadwell 1611	*Tel: Pendleton 2481*	*Tel: Sheffield 344391*	*Tel: Elgar 5811*

Also at Newcastle, Bedford, Cardiff, Bow, Coventry etc.

A METAL INDUSTRIES GROUP COMPANY

HYDRAULIC PRESSES
designed to suit your particular needs
from 5 to 200 tons capacity



Illustrated are two modern Hydraulic Presses showing the flexibility of design and construction in fabricated steel.

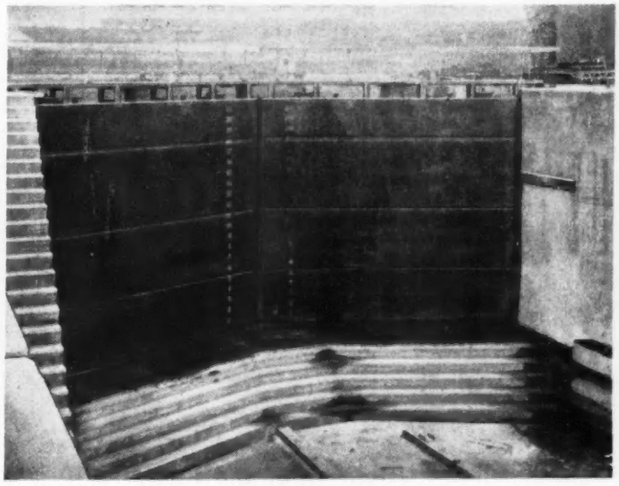
1. *100-ton self-contained Press with extended table and special die operating circuit for high-speed operation.*
2. *25-ton general purpose Press with double table and special long stroke Cylinder and Ram.*

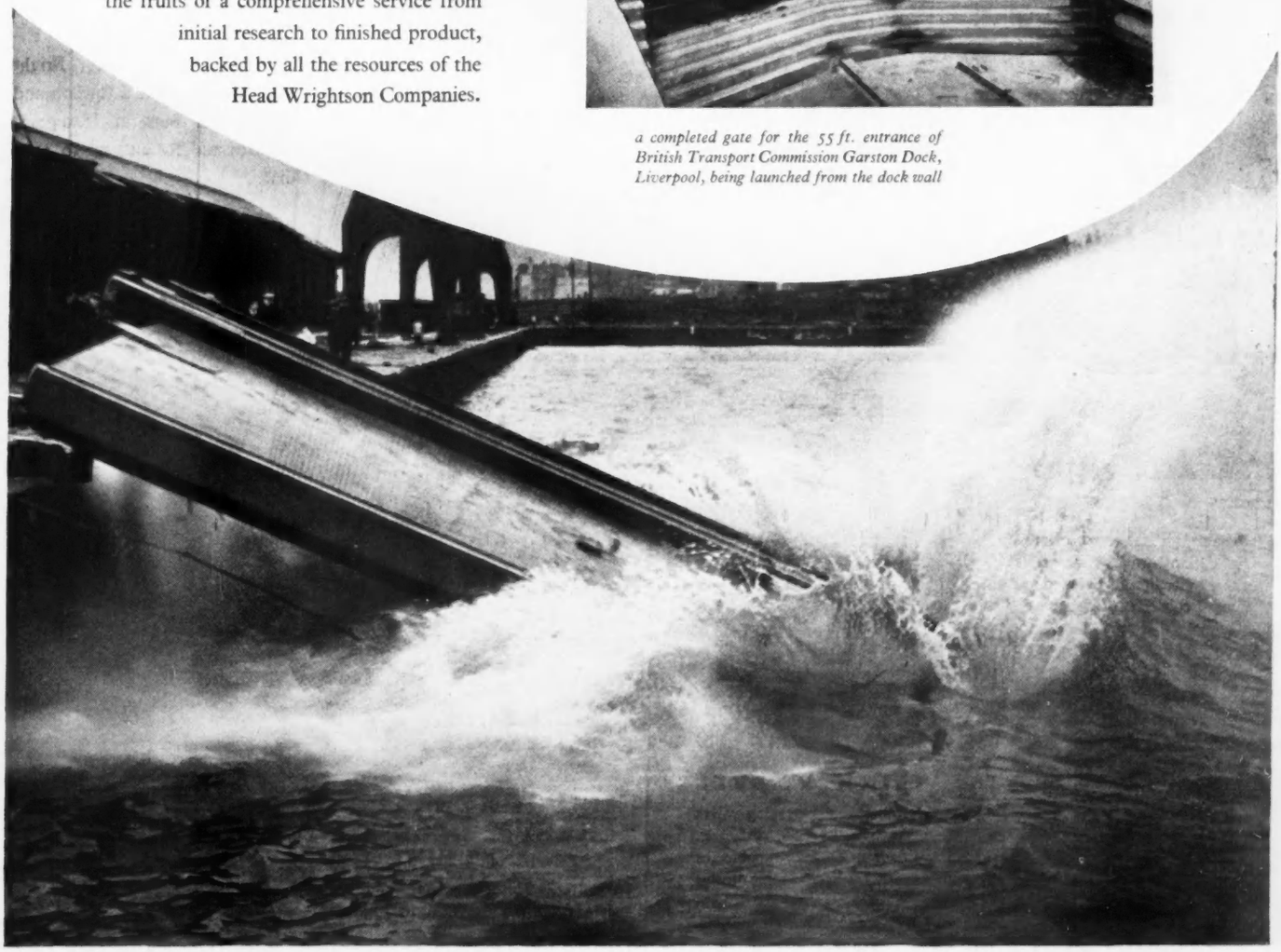
RHODES GILL & CO. LTD
212 WELLINGTON STREET, LEEDS, 1
Phone LEEDS 2004/5

DOCK GATES
of all shapes and sizes!

No two dock installations can be the same, every job brings its special problems, a fresh challenge to skill and ingenuity. Head Wrightson approach each one with the experience of over sixty years in the design and construction of dock gates and equipment. From Head Wrightson's Tees-side Works, completed gates are towed to sites all over the country and abroad or shipped in sections for assembly on the spot. These are the fruits of a comprehensive service from initial research to finished product, backed by all the resources of the Head Wrightson Companies.

a pair of gates in pos tion





a completed gate for the 55 ft. entrance of British Transport Commission Garston Dock, Liverpool, being launched from the dock wall

HEAD WRIGHTSON TEESDALE LTD

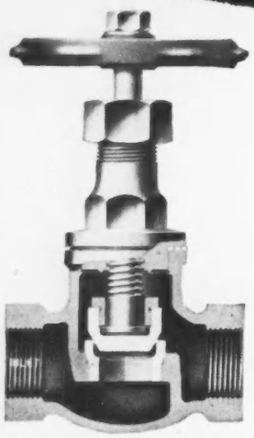
TEESDALE IRON WORKS THORNABY-ON-TEES

LONDON JOHANNESBURG TORONTO SYDNEY CALCUTTA

P.1694

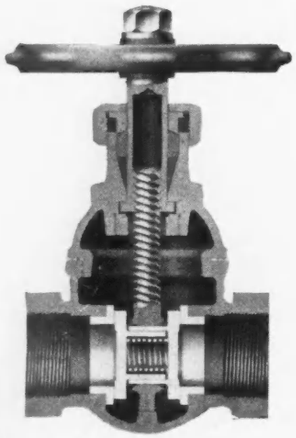
HOPKINSONS'
BRONZE VALVES
sizes up to 2 inch bore

IMMEDIATE DELIVERY FROM STOCK



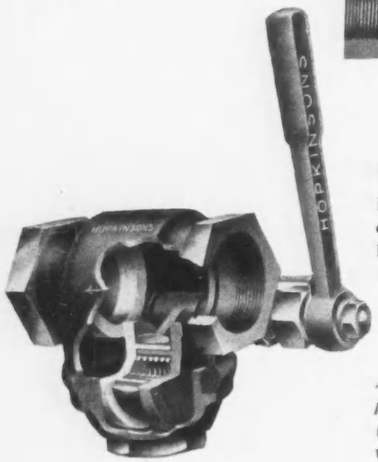
"S. T. S." VALVES

Sturdy general-purpose valves for isolating or regulating purposes. Screwed or flanged connections available.



PARALLEL-SLIDE VALVES

Reliable general-purpose valves for duties where the flow is in either direction. Screwed or flanged connections available.



LINK VALVES

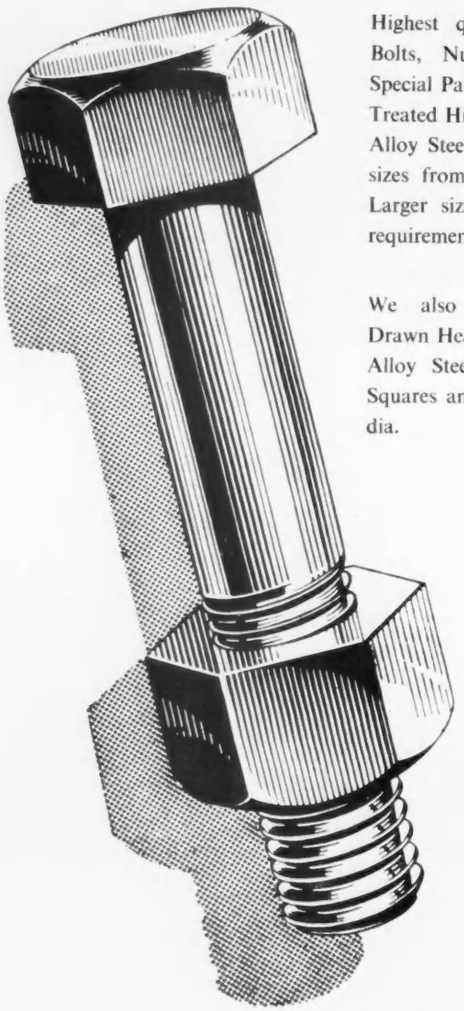
Robust quick-opening valves on parallel-slide principle. Easy to operate, suitable for many duties including process steam control, compressed air, thick heavy liquids, etc. With screwed connections.

All the above valves are for pressures up to 250 lb/sq. in. (steam) or 350 lb/sq. in. (cold water, air, oil, etc.)

HOPKINSONS LIMITED • HUDDERSFIELD
LONDON OFFICE 34 NORFOLK STREET STRAND W.C.2.

H6113

Marwin
BRIGHT & HIGH TENSILE
bolts



Highest quality Hexagon Head Bolts, Nuts, Studs, Sets and Special Parts, etc., in Bright, Heat Treated High Tensile Carbon and Alloy Steels for all industries, in sizes from ¼in. up to 3in. dia. Larger sizes supplied to special requirements.

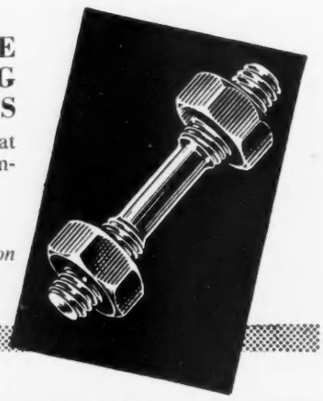
We also manufacture Bright Drawn Heat Treated Carbon and Alloy Steel Bars in Hexagons, Squares and Rounds up to 3½in. dia.

HIGH TEMPERATURE "CREEP" RESISTING STUD BOLTS

Specialised products that give great resistance when exposed to high temperature.

Sizes range from ⅜in. to 3in. dia.

Full technical details and Catalogue on request.



W. MARTIN WINN LTD.
DARLASTON · SOUTH STAFFS.
Phone: JAMES BRIDGE 2072 (5 lines). Grams: "ACCURACY," DARLASTON.

What do you do with your waste oil?

WELLS FILTERS enable waste oil to be used with complete confidence many times over.

The Wells special filter pads used in conjunction with the Wells patent syphon feed make waste oil clean again.

A. C. WELLS & CO., LTD

MOUNT ST., HYDE, CHESHIRE

Tel : HYDE 2953 *GRAMS : UNBREAKABLE HYDE*

famous for forgings of

all descriptions in alloy and Carbon Steels

(all heat treatment facilities)

T. S. FORSTER & SONS LTD

FORGEMASTERS AND ENGINEERS

COPPERAS BANK FORGE, SUNDERLAND

TEL: 2876 'GRAMS 'FRAMES' S'LAND

RBH

R. B. HILTON LTD

REFRACTORY AND INSULATING CONSTRUCTIONS

POWER STATIONS OIL REFINERIES

CHEMICAL PLANT INDUSTRIAL INSTALLATIONS

HEAD OFFICE **CRESSWELL PARK · BLACKHEATH · LONDON S.E.3**
Telephone LEE GREEN 4512/5

Glasgow Office 140, WEST GEORGE STREET, GLASGOW, C.2.
Telephone DOUGLAS 8356

PRESSURE GAUGES

AVAILABLE FROM STOCK IN ALL TYPES AND SIZES FOR ALL DUTIES

●●● OUR REPAIR SECTION IS AT YOUR SERVICE. PRESSURE GAUGES AND THERMOMETERS REPAIRED LIKE NEW.

B.S.S. LTD. SPECIALISE IN EQUIPMENT FOR STEAM, GAS, WATER, AND AIR, AND CATER FOR THE NEEDS OF ENGINEERS IN ALL INDUSTRIES. WRITE OR PHONE YOUR NEEDS TO:-

BRITISH STEAM SPECIALTIES LTD
FLEET STREET **LEICESTER.**
PHONE: LEICESTER 20885/6
Stocks at :—LEICESTER · LONDON . LIVERPOOL · GLASGOW
BRISTOL MANCHESTER . NEWCASTLE-ON-TYNE
BIRMINGHAM · DUBLIN . BELFAST

VEE-REG GLOBE VALVES

THE REGULATING STOP VALVES

FOR PRESSURES UP TO 650 P.S.I. AND TEMPERATURES UP TO 875 DEG. FAH.

SUITABLE FOR :-
STEAM, GAS, AIR, OIL, and HIGH PRESSURE HOT WATER

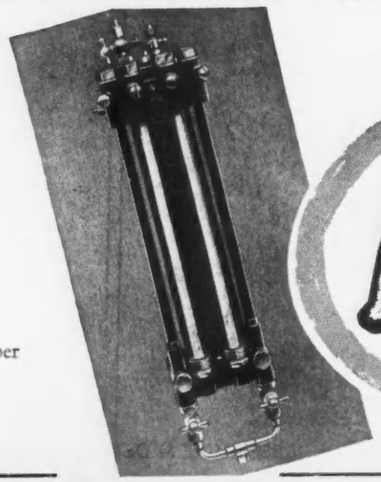
FLOWMETERS for petrol

Amal Flowmeters are precision instruments used extensively on engine test bed installations and enable the fuel flow to be directly read off at every instance of engine performance.

Their accuracy is within plus or minus 2 per cent.

Various models are available covering a range of 1 pint per hour to 400 gallons per hour.

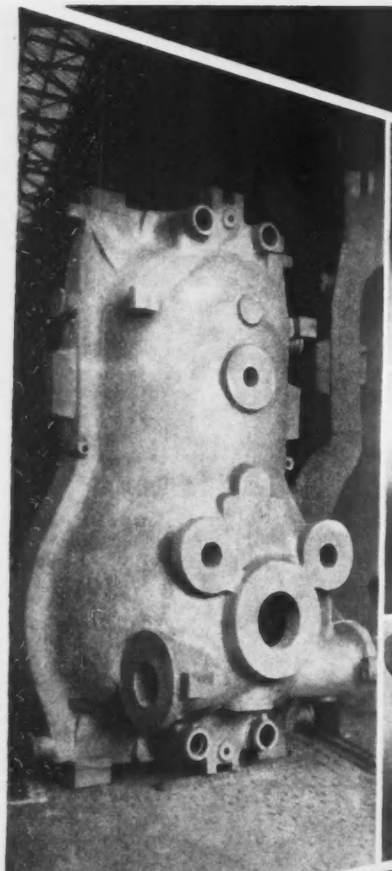
Send for list No. 323.



AMAL

AMAL LTD · HOLDFORD ROAD
WITTON · BIRMINGHAM 6
TEL: BIRCHFIELDS 4571

A 225



We specialise in the manufacture of intricate Steel Castings of large dimensions

Steel Castings of open-hearth steel in cast weights of 3 cwts. to 400 tons for general engineering and the construction of rolling mills - structural parts and casings of highly creep resisting steel for nuclear power plants, gas and steam turbines - highly stressed parts for Francis, Pelton and Kaplan turbines, for electrical engineering, for the chemical industry and many other fields, in the heaviest weights and made of high alloy electrical steel or BV degassed Vacuum steel. - We also produce free and drop forgings of high quality for all applications

We shall be glad to discuss your problems with you without any obligation

Bochumer Verein
für Gusstahlfabrikation AG. BOCHUM

Representatives for the U. K.: THE STAHLUNION COMPANY LIMITED
61 Pall Mall, London S. W. 1. Telephone: Whitehall 5315 (7 lines)

75 Years of Progress

...in HIGH PRECISION HYDRAULICS

We remind you that we are one of the oldest Hydraulic Manufacturing Companies in Britain and we make all the most modern equipment for every branch of British Industry. Engineering and Industrial undertakings of repute in Britain and beyond the seas are our customers.

Horizontal Hydraulic Pressure Pump
60 H.P. Three Throw

Enclosed type Horizontal Electrically Driven Three-Throw Hydraulic Pressure Pump with forced lubrication and totally enclosed crankshaft, connecting rods, crossheads and gearing. The speed reduction is obtained by a totally enclosed worm reduction unit.

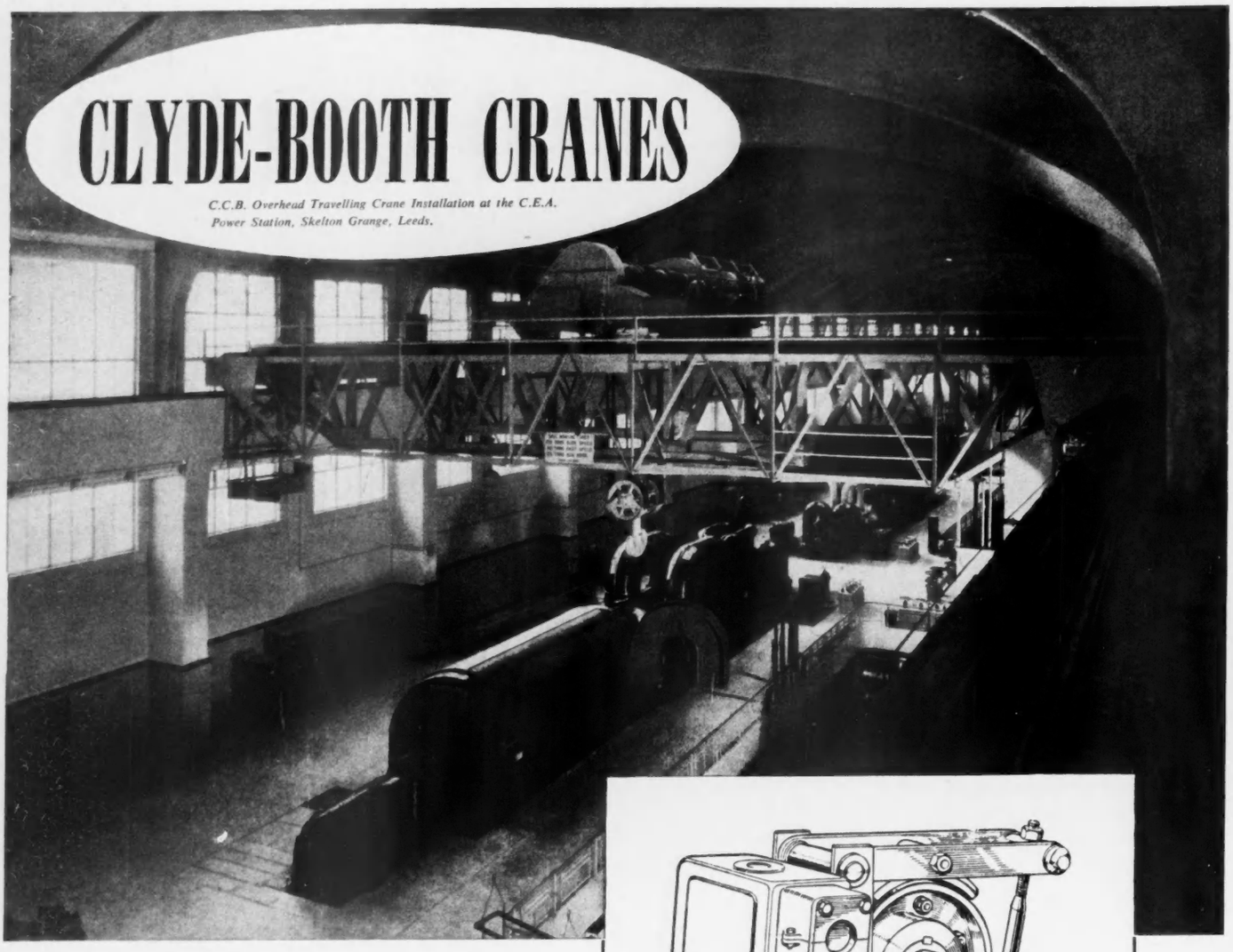
We also manufacture :—
Hydraulic Spring-Testing Machines, Hydraulic Spring Plate Forming and Cambering Machines, Hydraulic Presses, Pneumatic Spring Scragging Machines, Accumulators, Pumps, Valves and Intensifiers, Plate Bending Rolls, Punching and Shearing Machines.

HENRY BERRY & Co. Ltd.

CROYDON WORKS, LEEDS 10, ENGLAND · *Tel :* Leeds 75481-2 *Telegrams :* RIVETTER, LEEDS 10

CLYDE-BOOTH CRANES

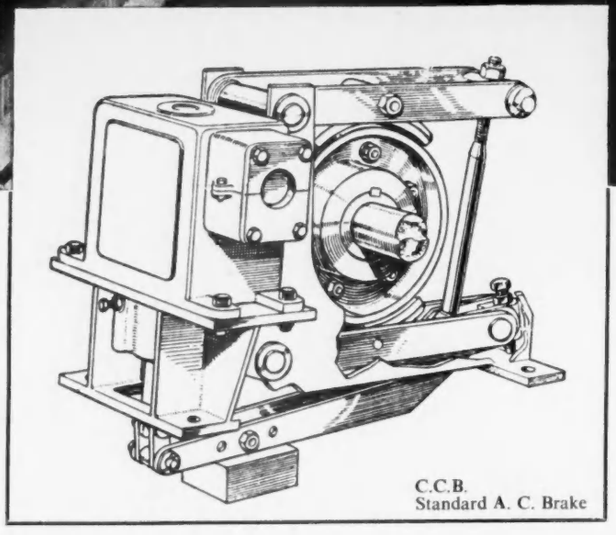
C.C.B. Overhead Travelling Crane Installation at the C.E.A. Power Station, Skelton Grange, Leeds.



Salient Features of
Clyde-Booth Design . . . .

ELECTRIC BRAKES....

The C.C.B. Solenoid brake is a compact all steel design, built to give long working life with a minimum amount of adjustment. Detail refinements include:



C.C.B.
Standard A. C. Brake

- **Hardened and ground pins working in phosphor bronze bushed links.**
- **Die pressed friction linings ground to form after fitting.**
- **Quick and easy adjustment to compensate for lining wear.**
- **Wide brake drum and shoes provide large friction area.**

CLYDE BOOTH

CLYDE CRANE & BOOTH LTD. *Incorporating:*

Joseph Booth & Bros.,
Union Crane Works, RODLEY, Leeds.
Telephone: Pudsey 3168 (6 lines). *Telegrams: "Cranes," Rodley.*

Clyde Crane & Engineering Co.,
MOSSEND, Lanarkshire.
Telephone: Holytown 412 (6 lines). *Telegrams: "Clyde," Motherwell.*

Roballo for all round efficiency

BALL BEARING SLEWING RINGS

NOW BRITISH MADE!

With outstanding design features, ROBALLO Slewing Rings have found a multitude of applications where long life and smooth and accurate rotation are required.

Write today for literature on this outstanding innovation.

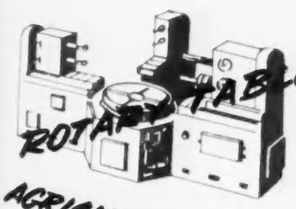
Roballo

WIRE RACE BALL BEARING RINGS

TRENCH DIGGERS

MIXING MACHINES

SCIENTIFIC INSTRUMENTS

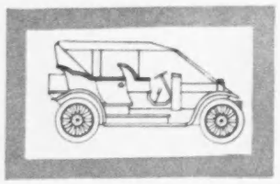


AGRICULTURAL MACHINERY

SWING BRIDGES

R2

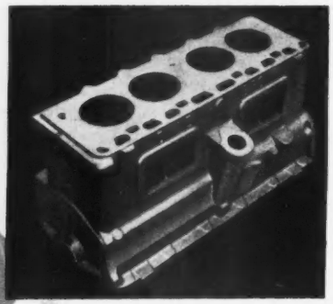
K



Sterling achievements
span the history of an era

. . . and help to make that era memorable.
The continuing success of Sterling Metals is due to their ability to supply
castings of the highest quality in the desired quantities at the right time.
Today as in the past, Sterling Metals offer the greatest technical experience
augmented by quality control of production which is second to none.
Sterling Metals are the acknowledged experts in casting aluminium and magnesium alloys
by sand, die and precision mould processes, and in making engine blocks
and cylinder heads in high duty iron.

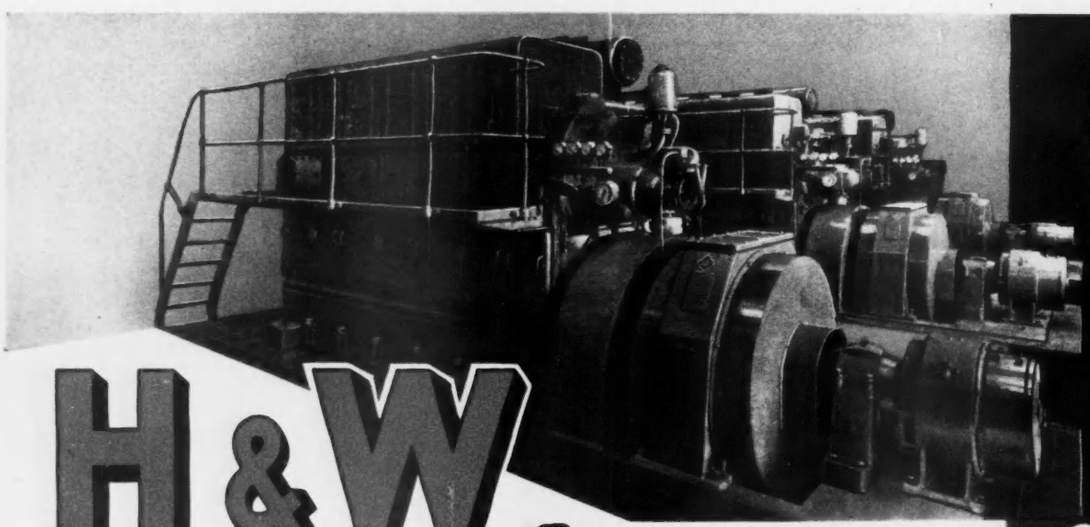
Sterling Metals are at your service



Cast iron cylinder block
for DB 25 tractor.
By courtesy of David Brown Ltd.

STERMET
REGD. TRADE MARK

STERLING METALS LTD
NUNEATON · Nuneaton 4221



Three H & W dual-fuel engines with H & W alternators. Each alternator set develops 330 kW at 428 r.p.m. and operates on sludge gas

H&W Alternator Sets

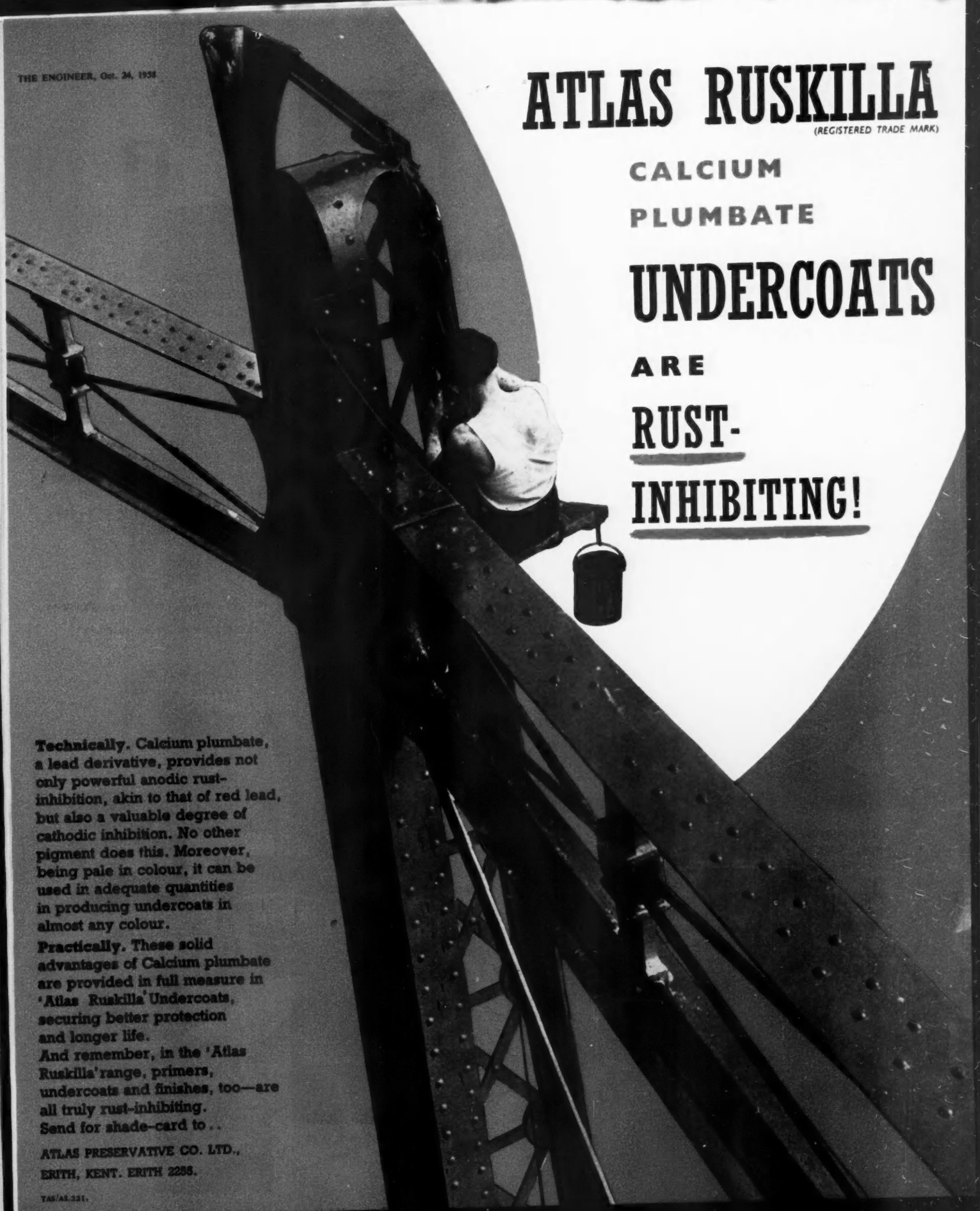
Alternators and engines are of H & W design and manufacture thus ensuring our undivided responsibility for the complete power set. We also supply the necessary control equipment.

H & W alternators supplied in all sizes from 100 to 5,000 kVA and voltages up to 11 kV. with H & W 2- or 4-stroke turbo-charged Diesel engines
("In line" and "V" type 4-st. Diesel engines can be supplied naturally aspirated or turbo-charged with or without air coolers)

HARLAND & WOLFF
LIMITED

Enquiries: Queen's Island, Belfast — London Office: 9 Whitehall, S.W.1

BELFAST GLASGOW LONDON LIVERPOOL SOUTHAMPTON



ATLAS RUSKILLA

(REGISTERED TRADE MARK)

CALCIUM PLUMBATE

UNDERCOATS

ARE

RUST-INHIBITING!

Technically. Calcium plumbate, a lead derivative, provides not only powerful anodic rust-inhibition, akin to that of red lead, but also a valuable degree of cathodic inhibition. No other pigment does this. Moreover, being pale in colour, it can be used in adequate quantities in producing undercoats in almost any colour.

Practically. These solid advantages of Calcium plumbate are provided in full measure in 'Atlas Ruskilla' Undercoats, securing better protection and longer life.

And remember, in the 'Atlas Ruskilla' range, primers, undercoats and finishes, too—are all truly rust-inhibiting.

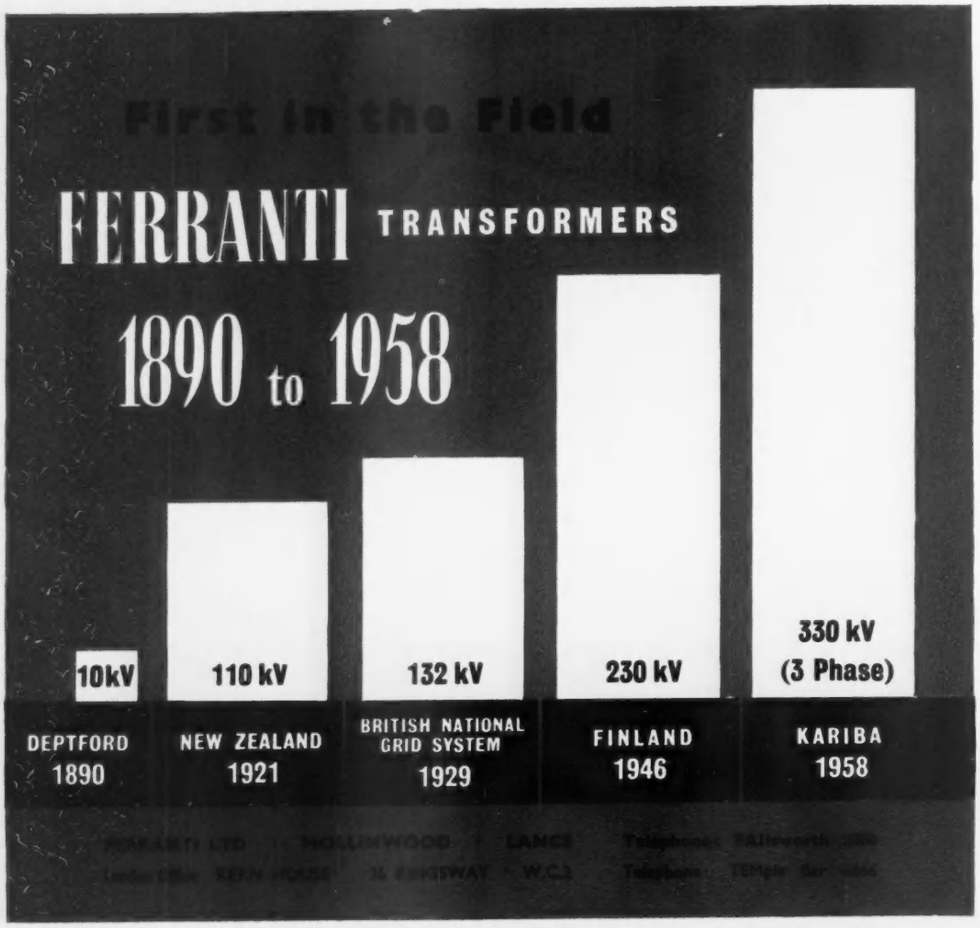
Send for shade-card to . .

ATLAS PRESERVATIVE CO. LTD.,
ERITH, KENT. ERITH 2255.

TAS/AS.221.

ATLAS RUSKILLA UNDERCOATS

Based on Calcium Plumbate



F FERRANTI

In the British Electrical Industry, Ferranti transformers are always first in the field thus satisfying the ever increasing demand for electric power.
The skill of Ferranti engineers over a period of more than 65 years has resulted in the award of contracts for the supply of transformers of the highest voltage and rating for the world's largest electric power projects.

Specify **FERRANTI** *transformers famous throughout the world*

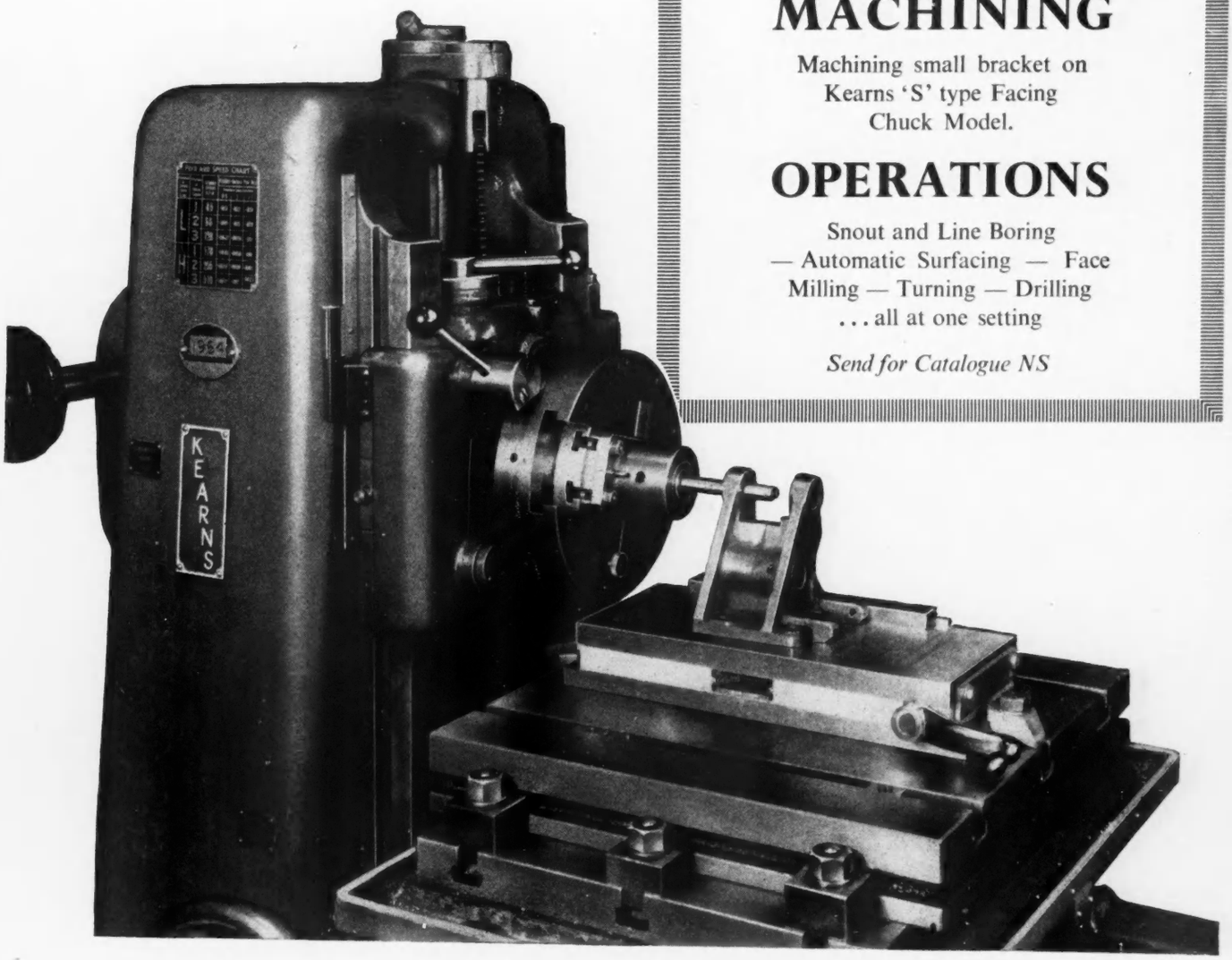
FT 217.2

AGAIN and AGAIN and AGAIN

SPIRATUBE...

. . . is proving industry's most versatile ducting. Light, Tough, Flexible, Retractable, Spiratube can be installed quickly and easily. It won't kink or buckle and can take 180° bends with ease. Economical too, because it can be dismantled and used many times. For fumes, dust, light materials, abrasives and scores of other applications SPIRATUBE is a standard specification. Clip this advertisement, pin it to your letterhead and send it to us. By return you will receive a fully illustrated brochure which tells you what Spiratube will do.

FLEXIBLE DUCTING LIMITED
103 SHUNA STREET, MARYHILL, GLASGOW. N.W.
Telephone: MARyhill 3729. *Telegrams:* FLEXIDUCT, GLASGOW. N.W.
An associate company of George MacLellan & Co. Ltd., Established 1870.



MACHINING

Machining small bracket on Kearns 'S' type Facing Chuck Model.

OPERATIONS

Snout and Line Boring — Automatic Surfacing — Face Milling — Turning — Drilling ... all at one setting

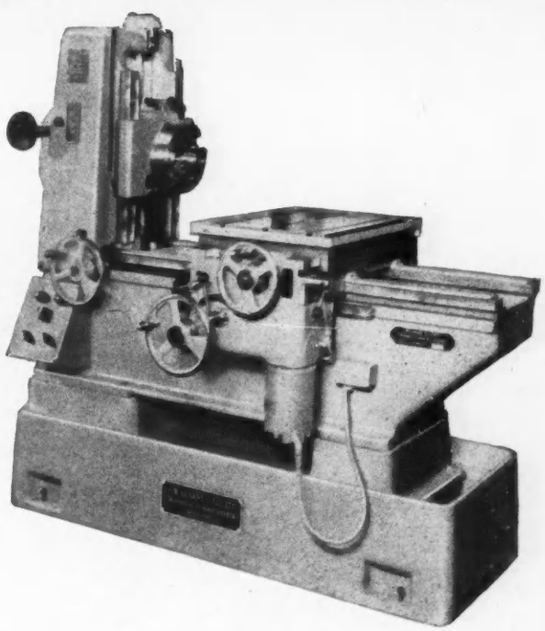
Send for Catalogue NS

Kearns

'S' TYPE

BORING MACHINE

—almost a workshop in itself

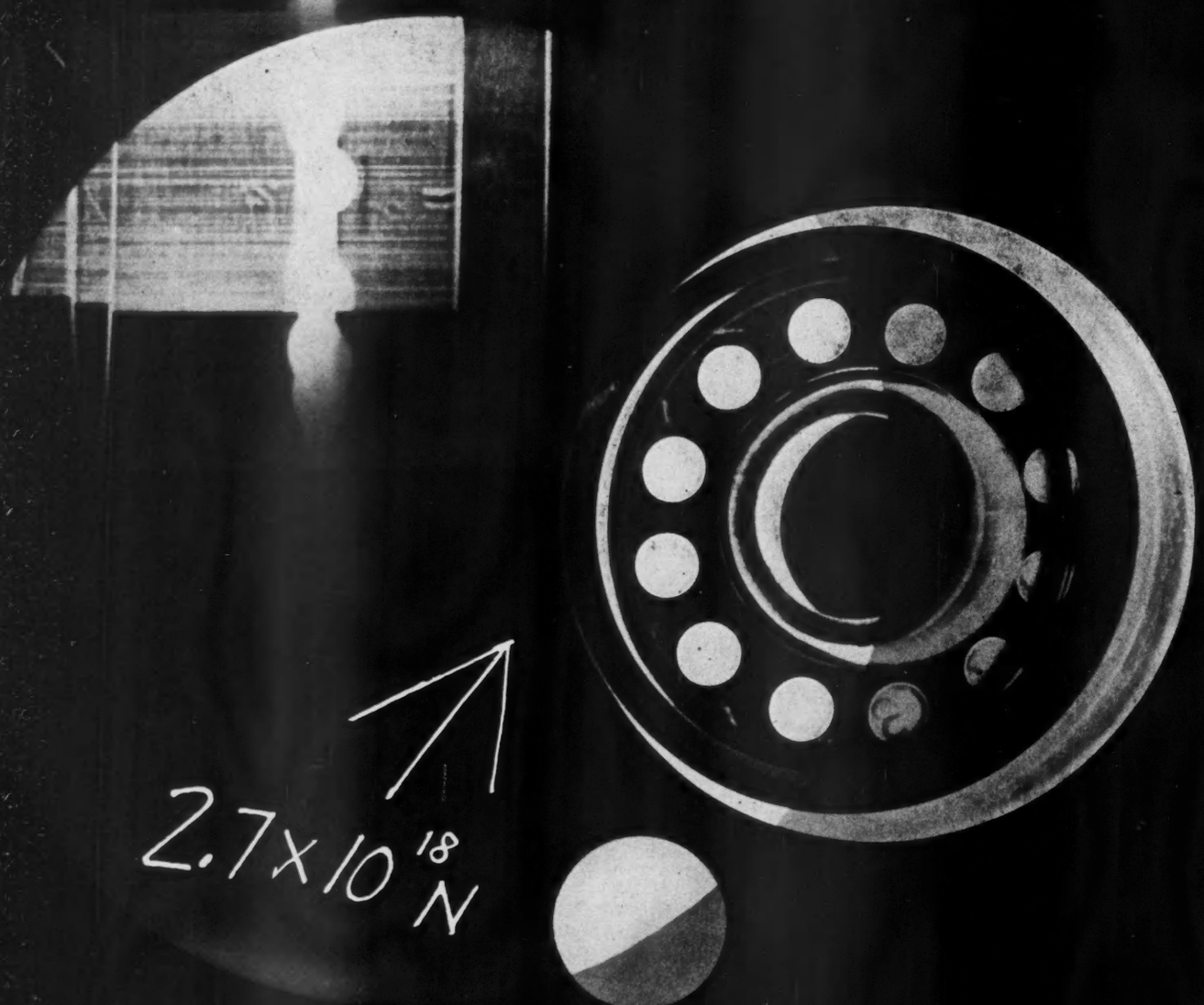


H. W. KEARNS & CO LIMITED BROADHEATH Near MANCHESTER

KSG 1

L

APL greases passed



their finals in June...

Radiation broke up the gel structure of conventional greases. They lost their lubricating properties, turned fluid or granulated. Completely new kinds of greases were needed by the atomic power industry for the bearings situated within the radiation field.

The Shell Group started working out radiation-resistant APL greases whilst most nuclear power stations were still on the drawing-board, and the research that went into them is characteristic of the way Shell set about doing things.

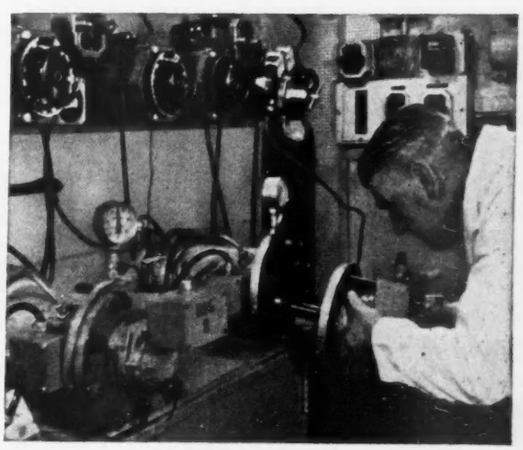
A team of research workers was assembled at Shell's Research Centre at Thornton. After four years of research and testing – both at Thornton and the A.E.R.E. Harwell – APL greases were ready for their finals. A sample was packed into a bearing and sunk into the B.E.P.O. pile. There it was not only subjected to mechanical working and high temperatures in CO_2, but also to an integrated pile dosage of 2.7×10^{18} thermal N. per sq. cm. plus associated radiation. APL greases sailed through their finals – and Shell are proud of it. They should be. For with these greases, Shell completed Britain's first range of Atomic Power Lubricants.

The moral of the APL story is that Shell research is supremely applicational. The Centre at Thornton is always ready to work with even the most specialised sectors of industry to produce the right lubricant for the job. If you and your organisation have any major lubrication problem, it will pay you to get in touch with your local distributor of Shell Industrial Lubricants.

The Research Story

Naturally a whole variety of greases were investigated. Conventional metallic soap greases were affected even by relatively low levels of radiation. Other greases based on synthetic and non-petroleum materials were examined and found to be equally unstable. Some of them softened appreciably and became tacky, whilst others hardened.

The Shell APL 700 series of greases are specially processed with an inorganic gelling agent, the base lubricant used being similar to the APL oils previously proved highly resistant to radiation. There were three series of tests. First tests were preliminary radiation tests at Harwell. Then the greases were tested for their lubricating qualities in a high temperature (400°F) pressurised CO_2 anti-friction bearing rig turning at 1,500 r.p.m. For the final tests in June, actual working conditions were simulated at Harwell.

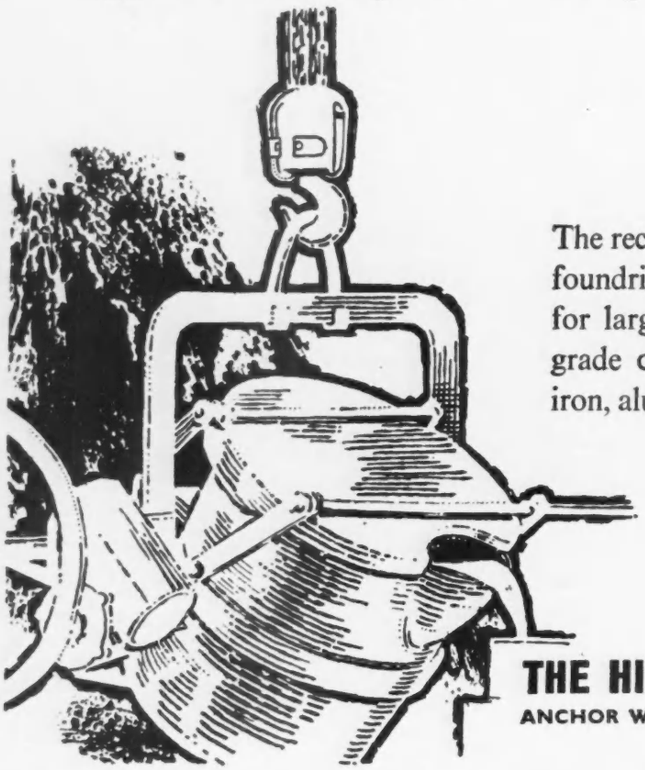


SHELL

ATOMIC POWER LUBRICANTS

another proof of Shell leadership in lubrication

For castings —— specify HILLTOP



The recent extensions to the Wednesbury foundries enable Hilltop to accept orders for large and small quantities of high-grade castings in grey iron, malleable iron, aluminium alloy, and yellow metals.

THE HILL TOP FOUNDRY CO., LTD.
ANCHOR WORKS, SMITH ROAD, WEDNESBURY, STAFFS.
Phone: Wednesbury 0294

INDUSTRIAL & TRACTION GEARS

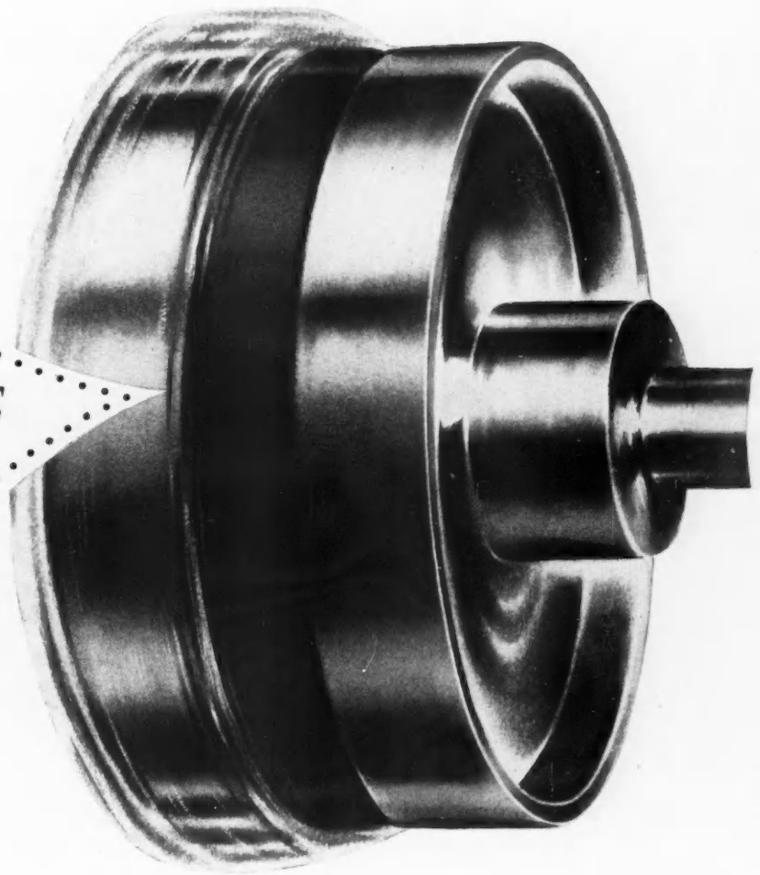
EPICYCLIC TYPE REDUCTION GEARS

Ratios 3: 1, to 1200: 1, Maximum Efficiency—minimum space: Horizontal or Vertical Mounting.
The most efficient method of obtaining a low speed drive, using a high speed motor, utilizing a minimum of space. We can offer single or multiple stage reductions from 3 to 1, up to 1200 to 1, for horizontal or vertical mounting.

Illustrated—MOTORIZED MULTIPLE STAGE UNIT—
Ratio 1100/1, 60,000 ins. lbs. torque output.

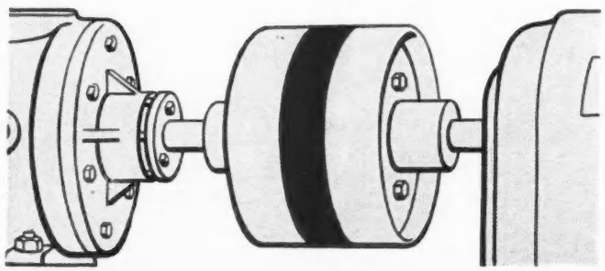
BOSTOCK & BRAMLEY LTD.
SPECIALISTS IN POWER TRANSMISSION
ODONTIC WORKS PHONE: STALYBRIDGE 3232-3 STALYBRIDGE A/21/6463/

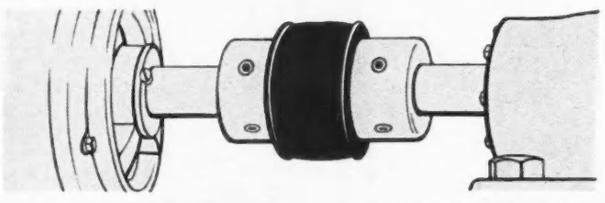
NO LOSS OF EFFICIENCY HERE through vibration or 'whip'



When machines must operate
under load fluctuation
or conditions of misalignment

DUNLOP *FLEXIBLE COUPLINGS HELP SMOOTH WORKING*





Dunlop Couplings consist of flexible rubber elements bonded to metal ends. The rubber can be compounded with varying degrees of stiffness as required by the task the coupling has to do, but the physical properties are always controlled within fine limits. Dunlop Flexible Power Transmission Couplings can be used with confidence in applications where precision is vital.

DISC COUPLINGS
For heavier equipment, operating at up to 96 h.p. per 100 r.p.m.

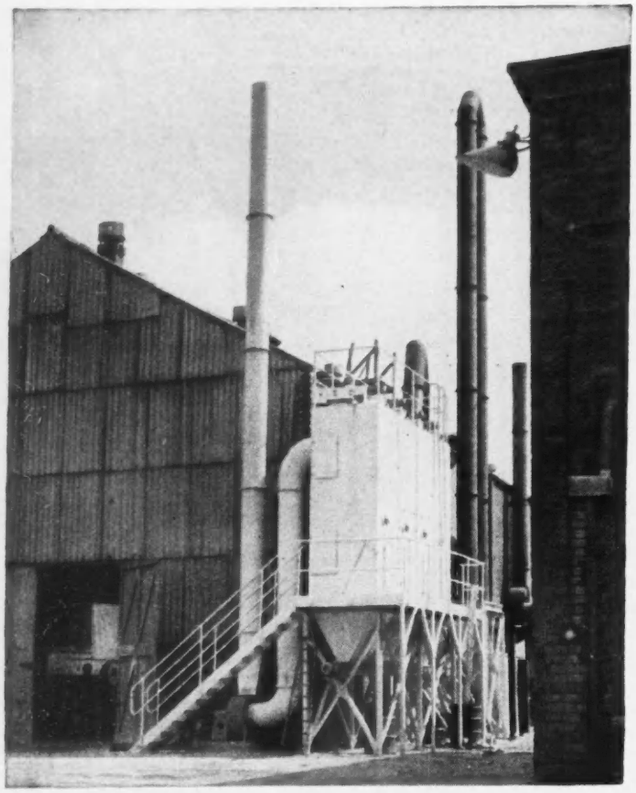
BARREL COUPLINGS
For light machines and motors, operating at up to 0.54 h.p. per 100 r.p.m.

For any problem in precision rubber engineering

CONSULT DUNLOP AT BLUE-PRINT STAGE

Dunlop Rubber Co. Ltd. (Engineering Components Division), Fort Dunlop, Erdington, Birmingham 24

swc/rcs



PONTIFEX
clears the air

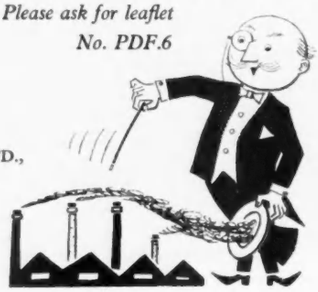
The fully automatic Filter Plant, here shown in operation, was installed by Pontifex for British Lead Mills Ltd., at Welwyn Garden City, to clean the gases from an oil-fired rotary furnace treating non-ferrous metals. It was completed, and working, three weeks ahead of scheduled delivery date. The absence of visible discharge from the exhaust stack should be noted.

Dust and Fume Recovery

The Pontifex Service, using equipment which is wholly British in design and construction, can solve *your* Dust and Fume problem — quickly, economically and effectively. 'Unit Construction' speeds up and simplifies installation: the unique arrangement of valves and manifolds cuts down power consumption. You save both ways — in initial cost and in running expenses.

A consultation will cost you nothing, will commit you to nothing. We will gladly design plant to meet your individual requirements or supply exhaust hoods, ducting, fans, cyclones or simple filters to order. Our advice will be, in every case, frank, helpful and impartial.

Please ask for leaflet No. PDF.6



PONTIFEX

H. PONTIFEX & SONS, LTD.,
DUST AND FUME DIVISION,
9-13 GEORGE STREET, MANCHESTER SQUARE, LONDON, W.1
TELEPHONE: WELBECK **8201** (6 LINES) · WORKS: BIRMINGHAM, LEEDS, LONDON

Superior
DROPFORGINGS

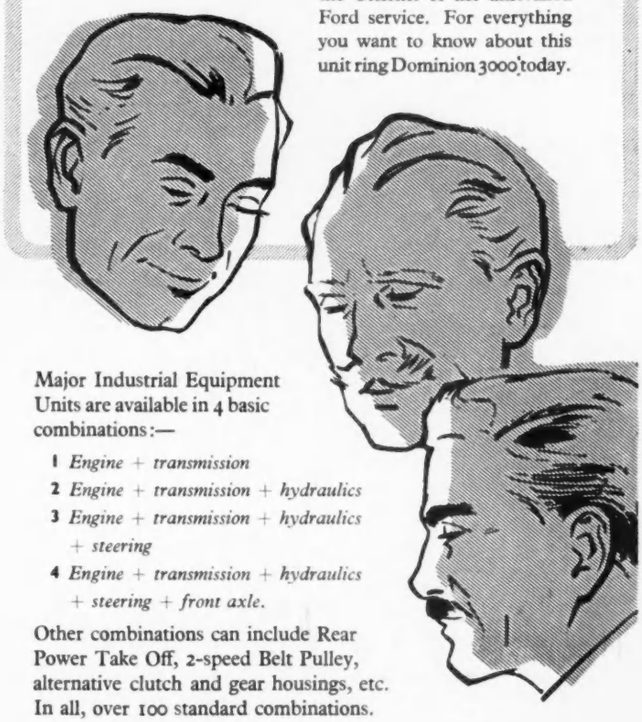
THE BLACKHEATH STAMPING CO. LTD.

BLACKHEATH · BIRMINGHAM

Telephone: BLACKHEATH 1448/9

To do the job properly IT MUST BE MAJOR EQUIPPED

You've designed the plant which will save time and increase output on some particular operation. Harness it to the sturdy power of a Major Industrial Equipment Unit and you're sure of a machine which will do the job properly — and keep on doing it week after week, month after month in the most punishing conditions. That's the kind of work the Major Unit, with its powerful, fuel-saving engine and sturdy transmission, was designed for. And your customers get all the benefits of the unrivalled Ford service. For everything you want to know about this unit ring Dominion 3000 today.



Major Industrial Equipment Units are available in 4 basic combinations:—

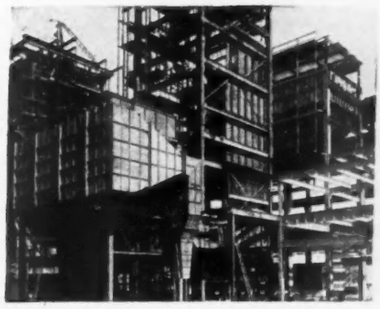
1 *Engine + transmission*
2 *Engine + transmission + hydraulics*
3 *Engine + transmission + hydraulics + steering*
4 *Engine + transmission + hydraulics + steering + front axle.*

Other combinations can include Rear Power Take Off, 2-speed Belt Pulley, alternative clutch and gear housings, etc. In all, over 100 standard combinations.

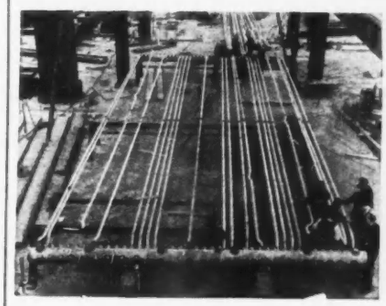
ENGINE DETAILS	Diesel	Petrol
CUBIC CAPACITY	3.61 litres	3.26 litres
COMPRESSION RATIO	16 : 1	5.5 : 1
BRAKE HORSE POWER AT: 1200 RPM	34.0	34.0
1400 RPM	40.0	38.0
1600 RPM	44.0	42.0

All enquiries to :—
INDUSTRIAL SALES DEPARTMENT TRACTOR DIVISION FORD MOTOR COMPANY LIMITED
DAGENHAM ESSEX Tel: Dominion 3000

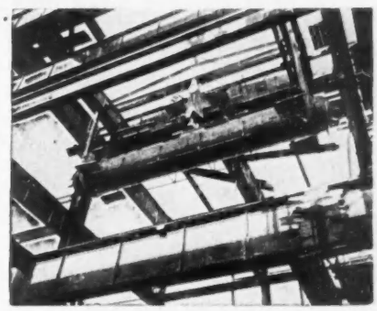
WISE BUYERS INSIST ON MAJOR POWER



Little Barford B Power Station. "Outdoor installation of 2 boilers".



Aberthaw Power Station. "Panel wall construction on site for one of 6 boilers".



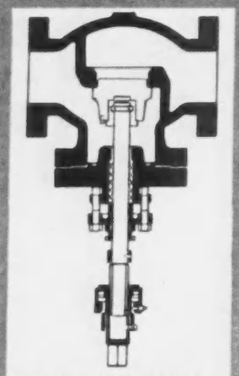
Drakelow Power Station. "Drum lift for one of 3 boilers".

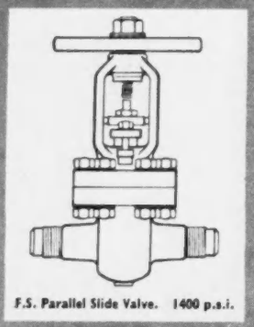
BOILERS UNDER CONSTRUCTION *by* FOSTER WHEELER

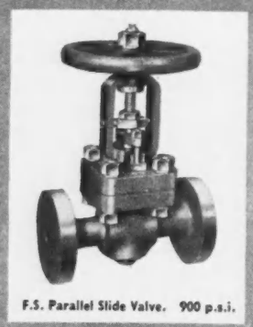
for the Central Electricity Generating Board.

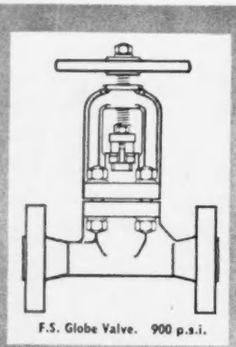
Northfleet Power Station. "Tube wall assembly for one of 6 boilers".

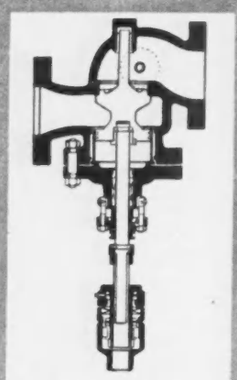
FOSTER WHEELER LIMITED
FOSTER WHEELER HOUSE, 3 IXWORTH PLACE, LONDON S.W.3.

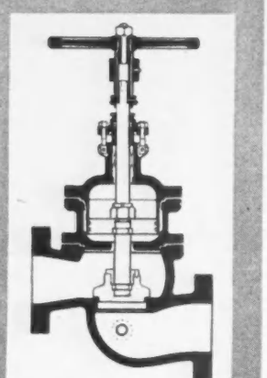

Astern Double Shut-off Valve.


F.S. Parallel Slide Valve. 1400 p.s.i.


F.S. Parallel Slide Valve. 900 p.s.i.


F.S. Globe Valve. 900 p.s.i.


Manœuvring Valve.


Self-Closing & Emergency Stop Valve.

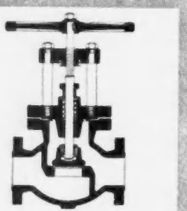
Having Valve Trouble?

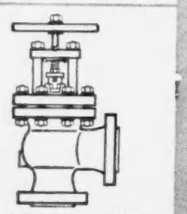
Steam leakage,
constant maintenance, etc.,
can be cured by fitting

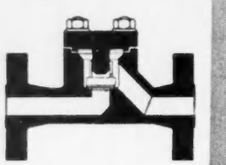
WEIR 'HARD FACED' VALVES

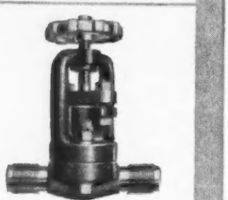
with consequent reduction
in fuel and labour costs

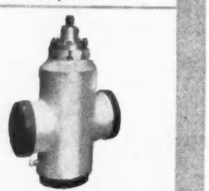
SUPPLIED IN FORGED AND CAST STEEL
TO MEET VARYING STEAM
AND TEMPERATURE CONDITIONS


5" Bore Globe Valve. 600 p.s.i.


4" Bore Angle Valve. 600 p.s.i.


F.S. Auto. N.R. Valve. 900 p.s.i.


F.S. ¼" Bore Fine Control Valve. 900 p.s.i.


Aluminium Valves.
As Supplied to U.K.A.E.A.

An order has been received for Main Isolating Valves, developed in collaboration with Lockheed Industrial Hydraulics Division, for the Pressurized Water Circuit of the Land Based Reactor Prototype of the Nuclear Powered Vessel H.M.S. "DREADNOUGHT."

Suppliers to the United Kingdom Atomic Energy Authority. On Admiralty Lists.

WEIR VALVES LTD.,

QUEENSLIE INDUSTRIAL ESTATE · GLASGOW, E.3

Telephone: SHETTLESTON 4201-4

In a matter of days...

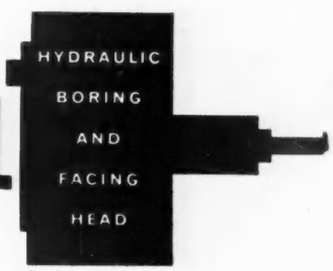
it's NEWS!

From the day the first advertisements appeared, enquiries for the Swintool self-contained Hydraulic Boring and Facing Head have been arriving by every post, from prospective buyers at home and overseas. Such swift reaction is not surprising. This is the only self-contained hydraulic tool in existence capable of carrying out any of the three operations — boring, facing and undercutting, without complicated resetting between operations. Further, there are no mechanical attachments required. Learn more about this unique device. Ask for copy of the new illustrated brochure containing full details and specification.

For further information, specification and details of demonstration please write to:-

SWINTOOL

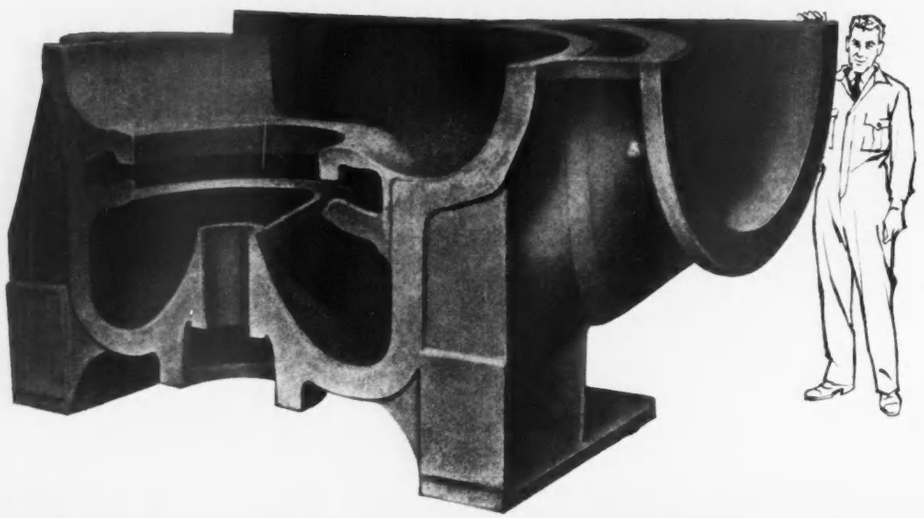
World patents applied for



ENQUIRIES FROM THE TRADE INVITED

SWINDON TOOL COMPANY LIMITED
INDUSTRIAL ESTATE, CHENEY MANOR, SWINDON, WILTSHIRE

a tricky job



whichever way you cast it

Half Pump Casing made from full pattern and without core boxes, weighing 4 tons 12 cwts. Cast in Meehanite by G. M. Hay & Co. Ltd., Glasgow.

Cast Iron Can Do it-if it's

MEEHANITE REGD.

The Dependable Metal

Meehanite Metal Foundries at your service

. . . yet well within the capabilities of a Meehanite foundry. For Meehanite Iron has all the qualities that such a casting needs —absolute soundness, pressure-tightness, strength, freedom from distortion, and good machinability.

Any of the foundries listed on the left will be glad to send you a free copy of the booklet 'Meehanite in the Service of Industry'.

Meehanite castings can be supplied in any quantity, large or small.

Ashmore, Benson, Pease and Company, Stockton-on-Tees. **The Butterley Company Limited**, Ripley, Derby. **Cameron and Roberton Limited**, Kirkintilloch. **Carmichael Bros. Limited**, Nile Street, South Shields. **Goulds Foundries Limited**, Newport, Mon. **John Harper (Meehanite) Limited**, Willenhall, Staffs. **G. M. Hay and Company Limited**, Glasgow. C. **A. Parsons and Company Limited**, Newcastle-on-Tyne, 6. **Qualcast (Ealing Park) Limited**, London, W.5. **Richards Foundries Limited**, Leicester. **Southern Foundries Limited**, Waddon, Croydon, Surrey. **Winget Limited**, Rochester.

THE INTERNATIONAL MEEHANITE METAL CO. LTD., MEERION HOUSE, 4 DOWNSIDE, EPSOM, SURREY · TELEPHONE: EPSOM 3507-9 · TELEGRAMS: MEERION, EPSOM
TA.938

Eight specialist companies make up the nuclear octave. Each sounds exactly the right note in terms of its own particular skills and experience. In combination they form N.P.P.C. which thus has all the resources necessary for the construction of complete nuclear power stations throughout the world.

At Bradwell, Essex N.P.P.C. are building a new nuclear power station for the Central Electricity Generating Board with a guaranteed output of 300 megawatts. This great enterprise is a commercial venture aiding Britain's economy and emphasising her world lead in the practical application of atomic power for peace.

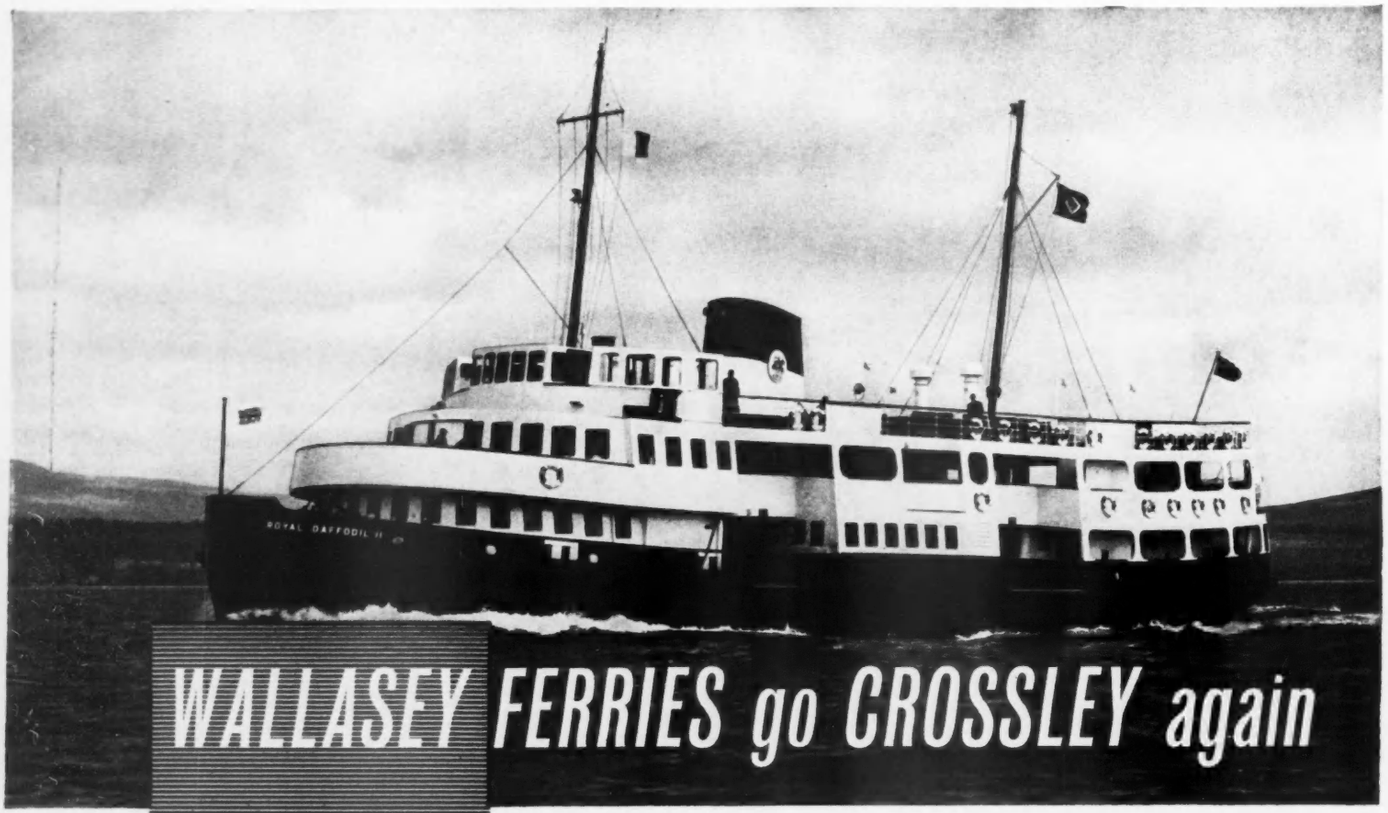
NPPC A Greater Britain through Nuclear Power

THE NUCLEAR POWER PLANT COMPANY LIMITED

C. A. PARSONS AND COMPANY LIMITED · A. REYROLLE AND COMPANY LIMITED · HEAD WRIGHTSON AND COMPANY LIMITED
SIR ROBERT McALPINE AND SONS LIMITED · WHESSOE LIMITED · STRACHAN AND HENSHAW LIMITED
ALEX FINDLAY AND COMPANY LIMITED · CLARKE CHAPMAN AND COMPANY LIMITED

BOOTHS HALL · KNUTSFORD · CHESHIRE

TGA NP2



WALLASEY FERRIES go CROSSLEY again

When the Wallasey Ferry Undertaking required a new ferry vessel to supplement their existing fleet they specified Crossley engines for the propulsion machinery. This was a direct result of the excellent service achieved during recent years on the exacting Liverpool-Wallasey run by their Crossley engined ferries, M.V.'s "Leasowe" and "Egremont."

The new vessel, "Royal Daffodil II"—built by James Lamont Ltd., like her sister ships has two Crossley "HRN 8" eight cylinder two-cycle Scavenge Pump Diesel engines, with a total output of 1360 b.h.p. at 350 revolutions per minute on twin screws.

Crossley machinery has helped to make the Wallasey Ferries one of the most modern and efficient ferry fleets in the world.

CROSSLEY DIESEL ENGINES

CROSSLEY BROTHERS LIMITED · OPENSHAW · MANCHESTER 11

C436

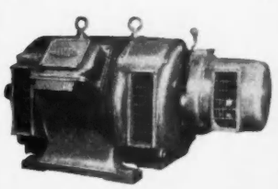
standing up or lying down

Before you choose a motor, consider what Harland offer — a comprehensive range of A.C. and D.C. machines of small and large power ratings, for all standard voltages and for vertical and horizontal mounting. For example the M range of machines are squirrel cage or slip ring motors from 30 to 400 h.p and the 'AV' range for outputs of 350-3,000 h.p. An outstanding characteristic of the D.C. range is the excellent commutation and high efficiency with consequent low maintenance and running costs. Each brush holder is adjustable and a compact tensioning arrangement is provided. The range covers 20 to 2000 h.p. 200 to 500 volts.

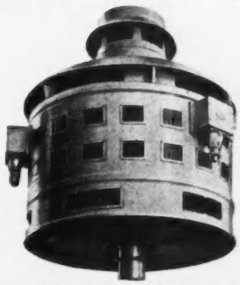
Screen protected, splash-proof, drip-proof and all other standard enclosures can be provided. There are also ranges of water-cooled motors, submersible motors, and special high efficiency motors, for continuous running.

We invite you to write for our descriptive literature.

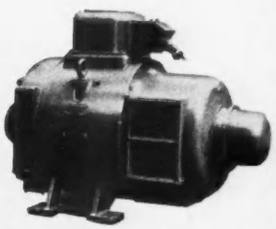
HARLAND MOTORS



'M' type A.C. squirrel cage or slip ring motors. Publication No. B.310



A vertical spindle A.C. machine from the 'AV' range. Publication No. B.330.



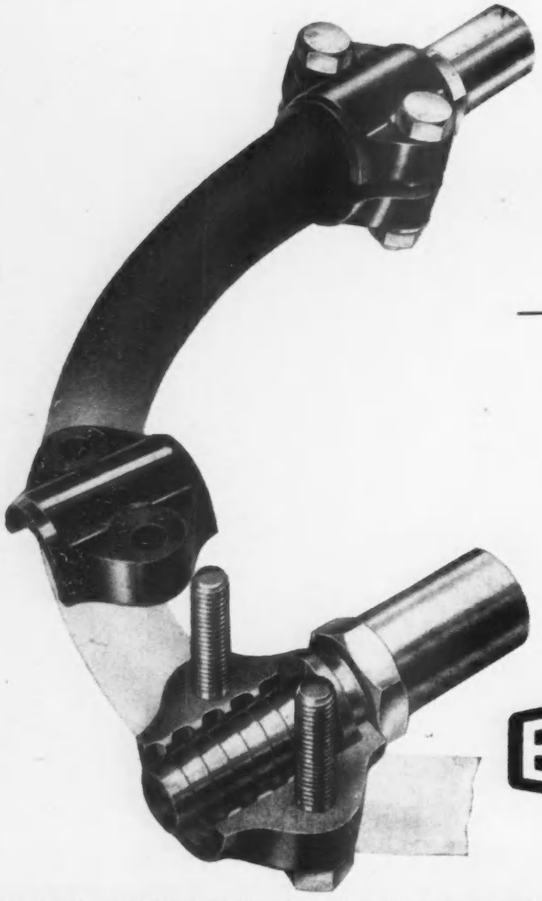
A typical D.C. machine from the comprehensive range available in all types of enclosures. Publication No. B.320.

THE HARLAND ENGINEERING CO LTD ALLOA SCOTLAND

LONDON AND EXPORT SALES OFFICE HARLAND HOUSE 20 PARK STREET W1

Branches in Bristol Glasgow Leeds Newcastle Nottingham Timperley (Cheshire) Wolverhampton & Overseas

P1130



Ermeto

TWIN SADDLE HIGH PRESSURE HOSE CONNECTIONS

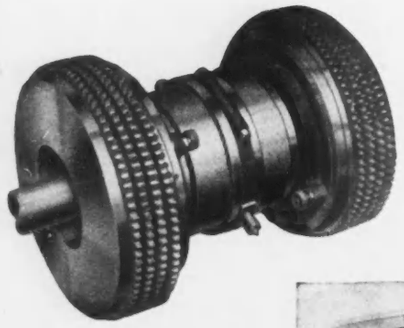
When specifying high pressure hose units consider the following advantages of Ermeto Twin-Saddle end fittings:

1 Easy to fit—only two spanners required.
2 Positively re-usable. Can be used time after time.
3 No need to strip rubber from hose-end.
4 Robust design: will stand any amount of hard wear.
5 Will hold higher pressures than the hose itself.
6 Available in single units up to 60 ft. long.

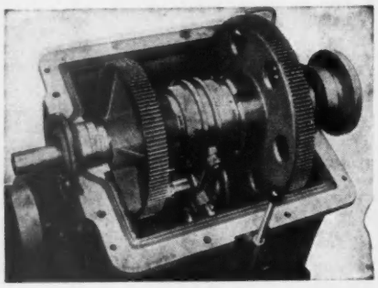
ERMETO
REGD TRADE MARK

Ermeto high pressure flexible hose units can be supplied for hydraulic, steam, and chemical uses. Further particulars and prices gladly sent on request

BRITISH ERMETO CORPORATION LTD Beacon Works Hargrave Rd. Maidenhead Berks
TEL: MAIDENHEAD 5100 (10 lines)



Powerful, Positive, Safe . . .



TAYLOR

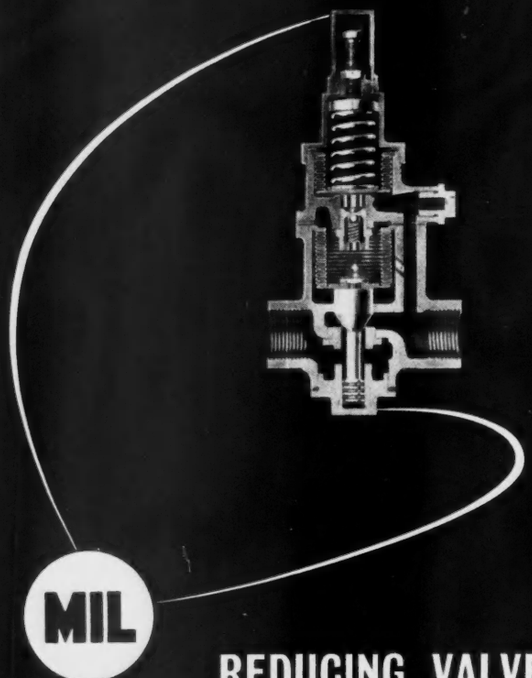
Multiple Disc CLUTCHES

Resiliency, sensitivity, ease of control and the ability to perform continuous heavy duty without frequent adjustment, make Taylor Multiple Disc Clutches a popular choice for machine tool, plant, civil and heavy engineering. Such characteristics are ensured by:—Heat treatment and total enclosure of all operating parts; positive locking; single point adjustment and precision manufacture on modern plant. A Taylor Clutch is a self-contained unit, easily assembled, quickly fitted and produced to perform many years of strenuous work.

The illustrations show a typical application. The Reid Gear Co., Ltd., required a powerful, sensitive and completely trustworthy clutch unit for their two-speed reduction gear, to transmit the enormous effort applied in actuating the emergency sluice gate on a Scottish Hydro-Electric Project. The features mentioned above qualify Taylor Clutches to satisfy such exacting demands because they constitute the very ingredients of strength and reliability—the choice was a Taylor Multiple Disc Clutch.

TAYLOR INDUSTRIAL CLUTCHES

TROWS UPPER WORKS · CASTLETON · LANCS.



MIL

REDUCING VALVES

GUARANTEED FOR 2 YEARS

ALSO STEAM TRAPS, WATER HEATER CONTROLS, H.P. HOT WATER VALVES

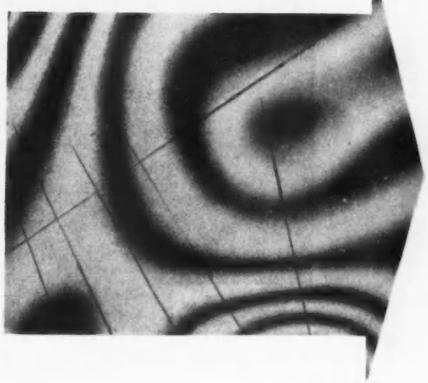
MIDLAND INDUSTRIES LIMITED
HEATH TOWN WORKS · WOLVERHAMPTON. Phone: 23901

A NEW CATALOGUE

This Comprehensive Catalogue, published by the Pioneers of Industrial First Aid, includes a section summarising British First Aid Regulations. It is available free to purchasers of First Aid equipment *who apply on their Company's letterhead, and refer to this Journal.*

CUXSON, GERRARD & Co Ltd
OLDBURY, BIRMINGHAM
ESTABLISHED 1878
Phone: BROadwell 1355

Tinsley



strain gauges

Electrical wire resistance strain gauges are accepted by engineers as one of the most important means of investigating stresses and strains in all types of structures and machines. The electrical resistance strain gauge consists of a grid of fine wire bonded to a paper or Araldite membrane which can be cemented to the surface under investigation. Connections are taken from the gauge to apparatus designed to give reliable and quick readings of the strain being measured.

Tinsley strain gauges are available in various designs & materials to meet individual requirements within three broad temperature ranges:—

Standard strain gauges..... 70°C Max.
Medium temp. gauges..... 300°C Max.
High temp. gauges..... 700°C Max.

A range of measuring instruments can be supplied for indicating and recording static strains.

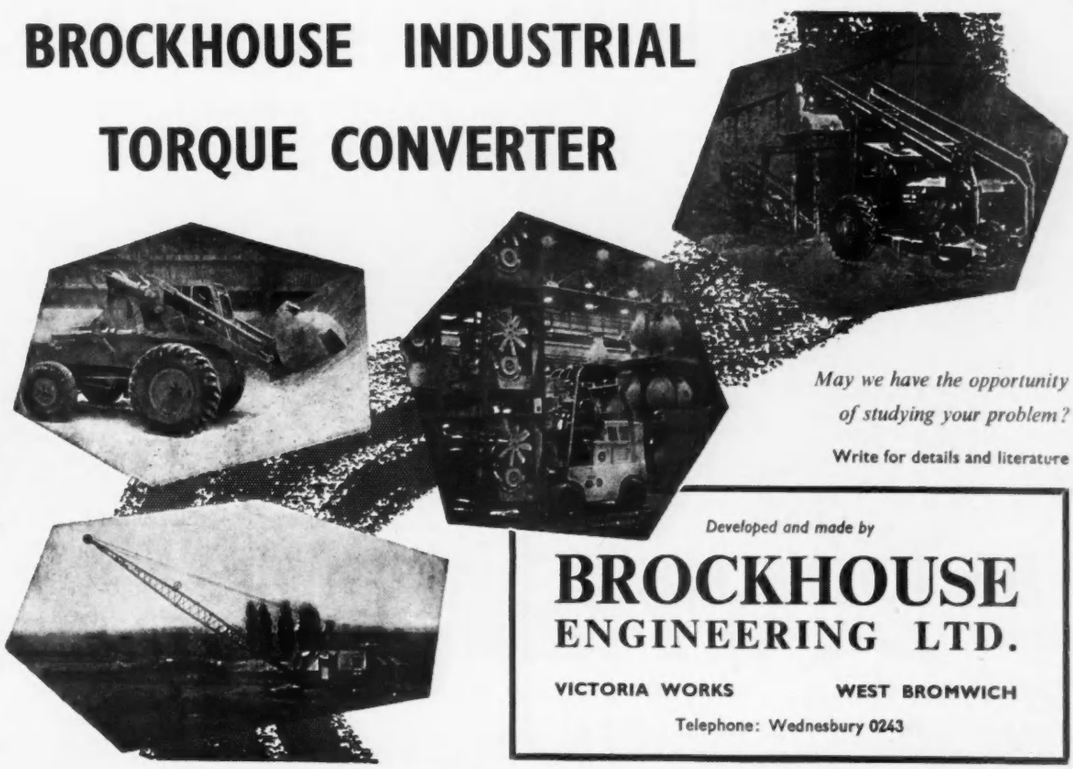
Write for Lists 210 and 210A, giving full particulars of Tinsley strain gauges and associated measuring apparatus.

H. TINSLEY & CO. LTD. WERNDEE HALL, SOUTH NORWOOD, LONDON S.E.25
Telephone: ADDiscombe 6046-7-8

CUT COSTS — SAVE TIME

WITH THE BROCKHOUSE INDUSTRIAL TORQUE CONVERTER

Fork Lift Trucks, Road Rollers, Earth moving equipment etc. Our illustrations show some of the varied applications to which the Brockhouse Industrial Torque Converter has been used.



See our exhibits at the Public Works Exhibition, Olympia, 10th—15th November, Stand No. 512, First Floor.

Some of the leading manufacturers who are using the Brockhouse Industrial Torque Converters in their equipment:
W. E. Bray & Co. Ltd., Conveyancer Fork Trucks Ltd., Coventry Climax Engines Ltd., Eddison Plant Ltd., David Brown Industries Ltd., Merton Engineering Ltd., Davey, Paxman & Co. Ltd., Ruston-Bucyrus Ltd., F. E. Weatherill Ltd., Hunslet Engine Co. Ltd., Ford Motor Co. Ltd.

May we have the opportunity of studying your problem?

Write for details and literature

Developed and made by

BROCKHOUSE ENGINEERING LTD.

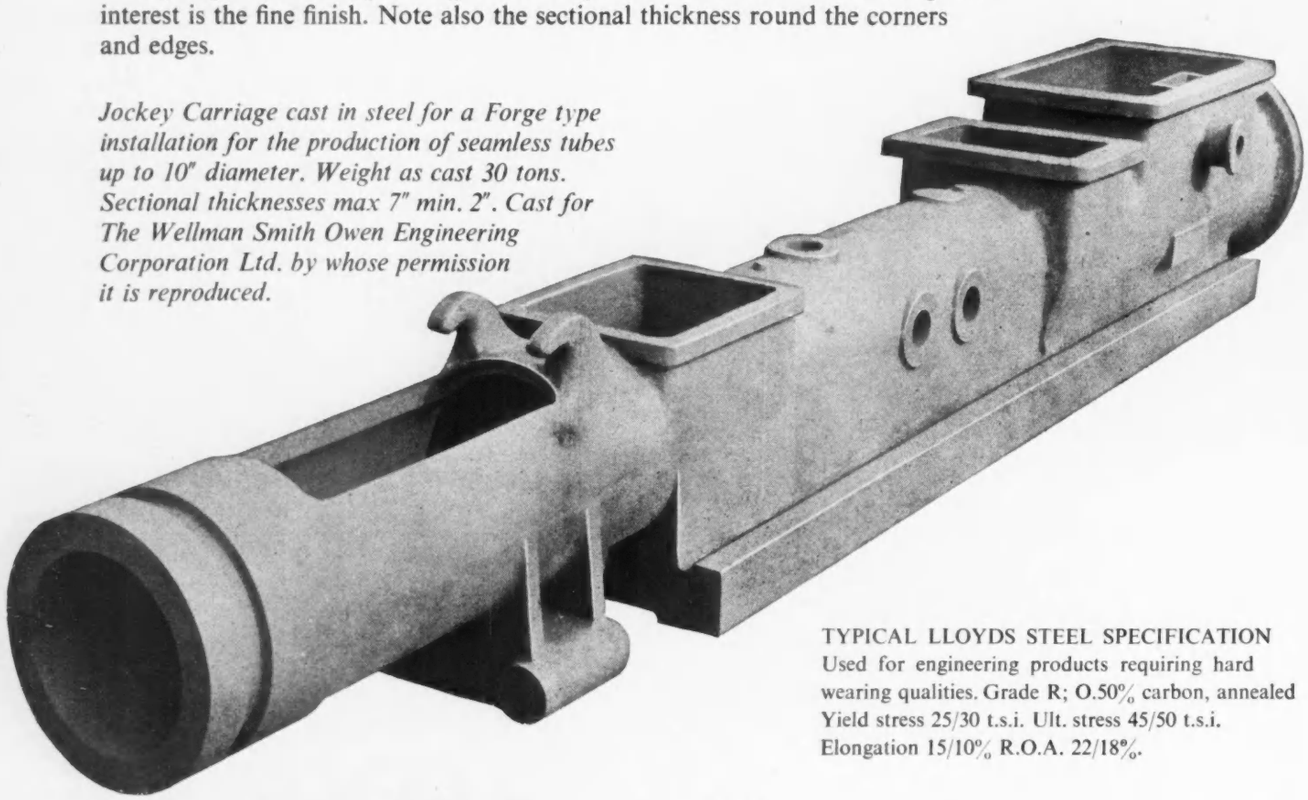
VICTORIA WORKS WEST BROMWICH

Telephone: Wednesbury 0243

cast for a "shockable" part

This jockey carriage is cast in steel for a forge type of installation for the production of seamless tubes up to 10″ diameter, and has to withstand unpredictable shock load. It is a good example of the versatility of steel casting, in that its sectional thickness varies from 2″ to 7″, essential requirements that make it almost impossible to fabricate by any other method.
Owing to good method planning this casting is free from defects and of especial interest is the fine finish. Note also the sectional thickness round the corners and edges.

Jockey Carriage cast in steel for a Forge type installation for the production of seamless tubes up to 10″ diameter. Weight as cast 30 tons. Sectional thicknesses max 7″ min. 2″. Cast for The Wellman Smith Owen Engineering Corporation Ltd. by whose permission it is reproduced.



TYPICAL LLOYDS STEEL SPECIFICATION
Used for engineering products requiring hard wearing qualities. Grade R; O.50% carbon, annealed Yield stress 25/30 t.s.i. Ult. stress 45/50 t.s.i. Elongation 15/10% R.O.A. 22/18%.

LLOYDS ***Britain's best equipped steel Foundry***

F. H. LLOYD & CO. LTD., P.O. BOX No. 5, JAMES BRIDGE STEEL WORKS, WEDNESBURY, STAFFS. TELEPHONE JAMES BRIDGE 2401

Print for Industry Advertisement

Know how . . .

When it comes to electrical repairs, the expression 'know-how' means a great deal of accumulated experience in an endless variety of applications. Added to that must be equipment and facilities on a large scale and test instruments of every kind. And if you multiply all that by fourteen works you have the B.E.R.L. Service organisation—the largest electrical repair company in Great Britain.

B.E.R.L.

BRITISH ELECTRICAL REPAIRS LTD

Empire House, Charlotte St., Manchester 1

Works at:

BATH, BIRMINGHAM, CARDIFF, CHESTERFIELD, EDINBURGH, GLASGOW, HAWICK, LONDON, MANCHESTER, NEWCASTLE, SWANSEA

dm BER 66

STEEL FRAMED BUILDINGS

FOR

Engineering Workshops, Foundries, Mill Buildings, Harbour Sheds, Go-Downs, Mine Buildings, Tea Factories, Sugar Factories, Rice Mills, Jute Mills, Cotton Mills, Rubber Factories, Bungalows, Etc., Etc.

SPECIALITIES:

Pit Headgear, Pumping Stations, Power Stations

Bridgework, Built Columns, and Riveted Work of all descriptions

BROWNLIE & MURRAY, LTD.

POSSIL IRONWORKS, POSSIL PARK, GLASGOW

LONDON: 32 QUEEN VICTORIA ST., E.C.4.

Telegrams: LIVADIA, GLASGOW
SEQUENCE, LONDON

You'd raise a doubtful eyebrow...

If told that removing grease and oily deposits was a simple job, you'd think of those filthy bits of cotton waste and splodges of dirty grease and sigh and sadly shake your head. But you'd be wrong. GUNK has solved all degreasing problems and does the dirty work for you. Simply brush on GUNK—then hose or rinse off with water. As if by magic all traces of grease and oil disappear. There's nothing finer for the speedy removal of dirt, grime, grease, oil and sludge.

Gunk

THE WORLD'S FINEST

DEGREASANT

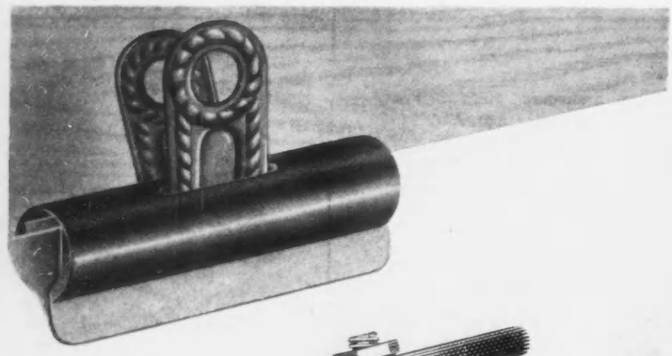
Supplied ready for use in 5-, 10- and 40/45-gallon drums. Send to-day for a free sample and prove for yourself the effectiveness of GUNK.

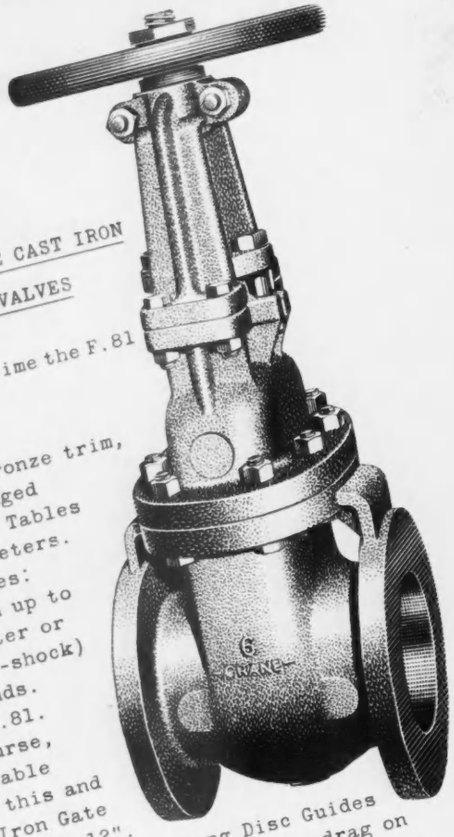
Manufactured by :-

BENNETT (HYDE) LTD

BOSTON MILLS, HYDE, CHESHIRE

Telephone : 1377 (3 lines)





BULLETIN ON CRANE CAST IRON
WEDGE GATE VALVES

..featuring this time the F.81

Specification: Bronze trim, rising stem. Flanged British Standard Tables "D" and "E" diameters. Working pressures: saturated steam up to 100 pounds. Water or oil (cold, non-shock) up to 200 pounds. Besides the F.81, Crane, of course, make innumerable variants of this and other Cast Iron Gate Valves from 2" to 12". All have these features: long Disc Guides which seat Discs properly, minimise drag on seat faces, and prolong valve life. Shoulder type Seat Rings prevent rings from loosening. Two piece Ball-Type Gland prevents binding on stem—even when gland bolt nuts are pulled up unevenly. All are available in bronze trim or all-iron—with screwed or flanged ends (according to size)—with rising or non-rising stem. According to trim they are suitable for use with steam, water oil or gas services.

CRANE

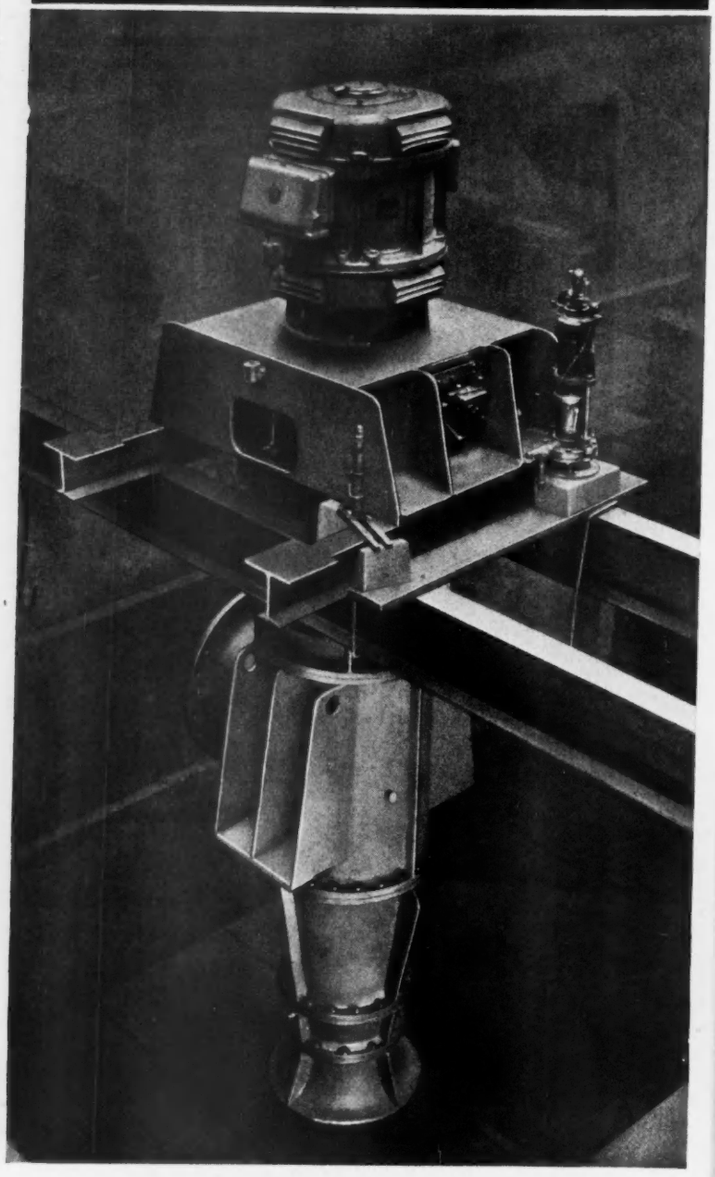
VALVES OF BRONZE, CAST IRON AND CAST STEEL

CRANE LTD., 15-16 RED LION COURT, FLEET ST., LONDON, E.C.4. Works: IPSWICH

Branches: Birmingham, Brentford, Bristol, Glasgow, London, Manchester

V.14

DRYSDALE



Axial Flow PUMPS

Drysdale Axial Flow Pumps are available in a wide range of sizes in vertical, horizontal and inclined types for land and marine duties.

Where the characteristics of the pumping service are suitable for the employment of the Axial Flow Type Pump a considerable saving in installation and operating costs can be effected.

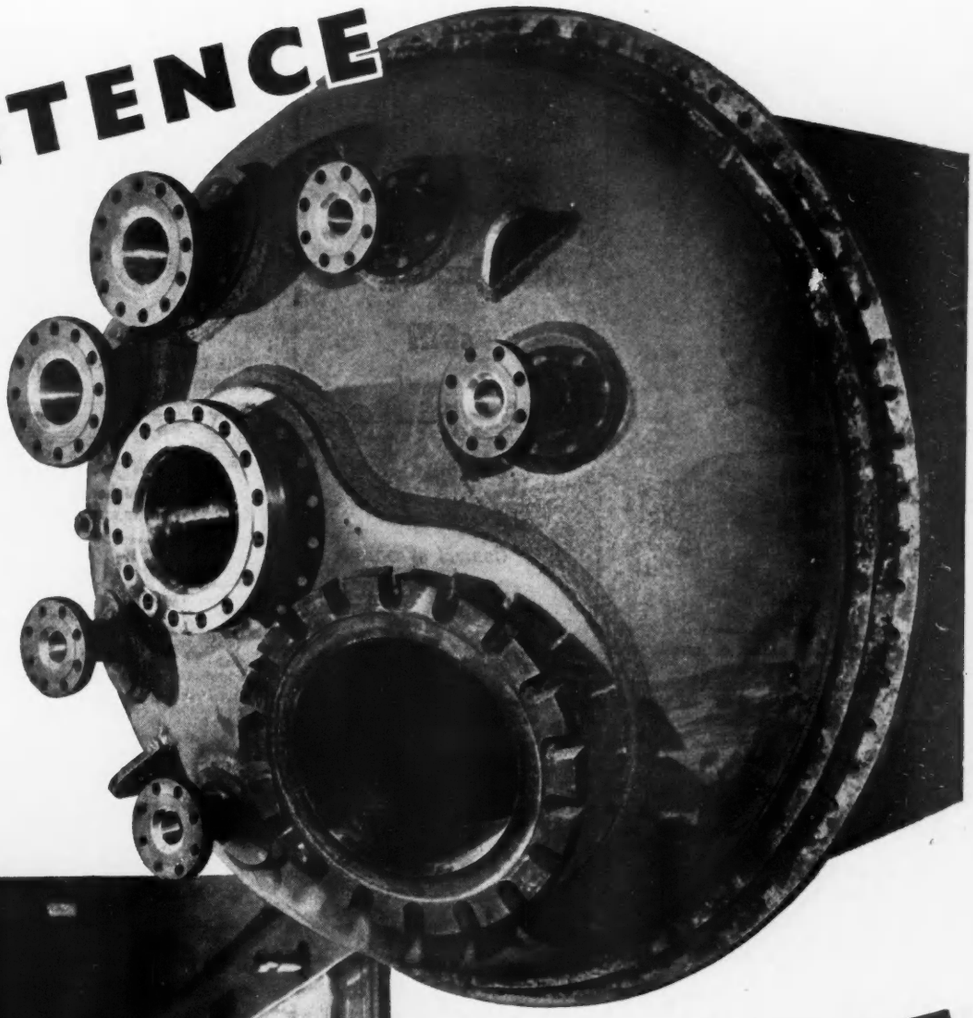
As makers of both Axial Flow and Centrifugal Pumps, our technical services are at the disposal of customers to advise, if required, as to the best selection.

CONDENSER CIRCULATING : SEWAGE PURIFICATION : LAND DRAINAGE : WET BASIN IMPOUNDING : STORM WATER DISPOSAL IRRIGATION : TRANSFORMER OIL CIRCULATION : HOT WATER HEATING SYSTEMS, ETC., ETC.

DRYSDALE & Co. LTD.

YOKER . GLASGOW

COMPETENCE



Head of a 6ft. dia. Autoclave, spun on the Harvey "Rotarpress" from a stainless steel disc 1⅝in. thick. Designed for a working pressure of 500 lbs./sq. in.

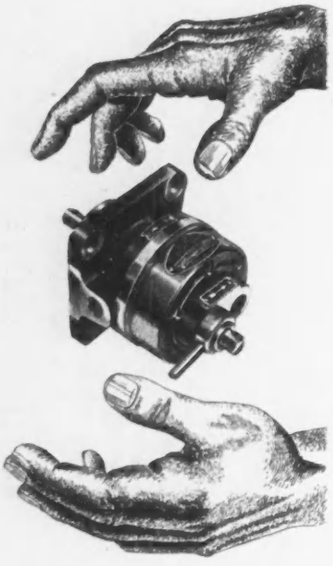
VIGILANCE

KEYNOTES OF

Harvey

FABRICATION

G. A. HARVEY & CO. (LONDON) LTD. Woolwich Road, London, S.E.7. Telephone: GREenwich 3232 (22 lines)



More accurate than human skill itself

Hydraulic Control of motion

Paradoxically, the product of human skill is more accurate than human skill itself. This is particularly so in the case of Savery Hydraulic Pumps. Countless thousands of Savery Pumps are in use throughout the world working with precision that neither human skill nor other means can match. Next time you're considering control of motion remember Savery Hydraulic Pumps first. Savery Pumps can be supplied with fixed or variable delivery.

FOR FURTHER DETAILS OF

SAVERY HYDRAULIC PUMPS

WRITE TO

THOMAS SAVERY PUMPS LIMITED

BRACEBRIDGE STREET, BIRMINGHAM 6 : Telephone: ASTon Cross 1316-7

ODDIE FASTENERS

PAT. NO. 507249

THE GENERAL PURPOSE FASTENER FOR ENGINEERS.

Simple—Positive—Self Locking. Made in a variety of types and sizes. Special Fasteners to suit customers' requirements.

Used on aircraft, automobiles, coaches, caravans, rail coaches, electrical, radio and radar units, refrigerators, marine craft, display equipment, etc.

For quickly detachable doors, covers, panels, access covers, etc.

For full details and literature apply to

ODDIE BRADBURY & CULL LTD — **PORTSWOOD RD.** — **SOUTHAMPTON**

TEL: 55803 CABLES: FASTENERS, SOUTHAMPTON

Clean Feed Water means higher boiler efficiency and lower fuel costs!

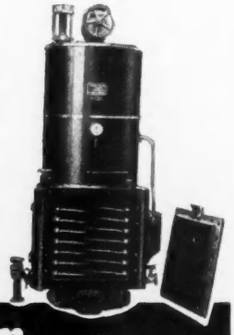
Feed water that deposits scale on boiler heating surfaces is a prime cause of overheating and subsequent tube collapse. And, remember, the majority of town water supplies, as well as sea-water, are heavy depositors of scale.

A Caird & Rayner Evaporator takes all the harm out of sea-water and provides a full supply of clean feed water to the boilers.

Not only is boiler efficiency raised and maintenance reduced appreciably, but substantial fuel savings will be seen as well.

Evaporators can be supplied to cope with feed water to any required rate. Further details will gladly be supplied on request.

EVAPORATORS AND CONDENSERS, FEED WATER HEATERS. FEED WATER FILTERS. EXHAUST STEAM OIL SEPARATORS. OIL FUEL HEATERS.



Caird & Rayner LTD

777 COMMERCIAL ROAD, LONDON, E.14. TELEPHONE EAST 3216 (3 lines) TELEGRAMS VAPORITE LONDON

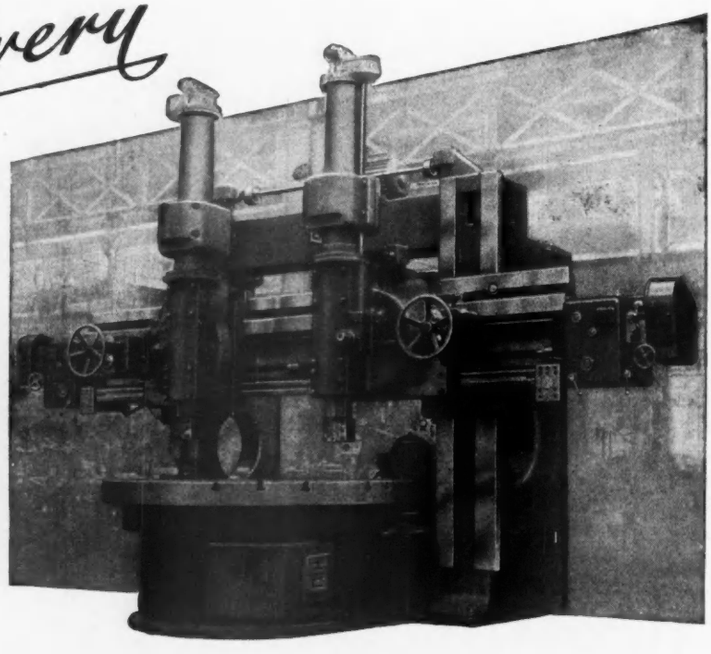
DHB/2712

"CRAVEN" 5' 0", 6' 0" and 7' 0"

VERTICAL BORING & TURNING MILLS

OF NEW DESIGN CAN NOW BE OFFERED

For Early Delivery



These machines are of heavy construction, each with a 30 h.p. constant-speed table driving motor and a twelve-speed gear box. Feed traverse to each saddle and its ram is by an independent variable-speed motor, and additional constant-speed motors are used for all quick traverse movements.

Duplicate control stations give complete pushbutton operation of the main motor and full selection of the ram and saddle movements, including change-over from feed to quick traverse and vice versa, the various engagements being made by magnetic clutch operation.

CRAVEN

CRAVEN BROTHERS (MANCHESTER) LIMITED

VAUXHALL WORKS · REDDISH · STOCKPORT · ENG.

Electrical Aids in Industry *Data Sheet* **No. 2**

Induction Heating-1

Electro-magnetic induction was discovered by Faraday and used by him to evolve the electric motor. In some cases, induction can be a nuisance by causing heat losses to arise from induced eddy currents in nearby pieces of metal, but in industry today those heat losses are being turned to good account as a method of metal heating.

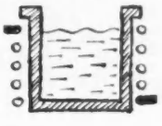
Induction heating produces heat only in the work piece. This is a fascinating and spectacular process which has the additional merit of being extremely effective. An important feature of induction heating is that it gives rapid temperature rise with no time lag, starting being instantaneous. Perhaps its greatest advantages are that it can be used in automatic processes and does not demand skilled labour.

Induction heating can deal efficiently with all the applications outlined below, and including metal melting, preheating and stress relieving, surface hardening, heating of large components, preheating of steel tubes for manipulating, heating for shrinking, for forging and extrusion, as well as for the heating of vessels. There are various methods of applying it, the method to be used being dictated by the application.

Technical details relating to the choice and use of individual types of induction heating will be set out in a subsequent data sheet.

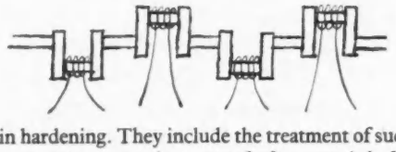
Metal melting

The oldest and largest application of induction heating lies in the melting of metals. The outstanding advantages are: freedom from deleterious gases and products of combustion and other contaminants, rapid speed of melting, low running costs, improved working conditions and reduced metal loss.



Metallurgical processes

This covers a large variety of processes which may be basically divided into surface heating and through heating. Most processes fall into the former category and are used for the purpose of



skin hardening. They include the treatment of such components as: pins, camshafts, crankshafts, rollers, cylinder liners, gear teeth, rocker arms and shafts and valve stems.

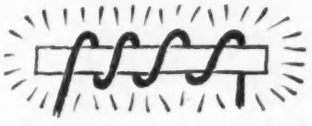
5857

Through Heating

When the current in an induction coil is maintained for a longer period it results in the heat engendered in the work piece penetrating to a greater depth and eventually throughout the piece. It is largely used for the heating of slugs and billets, for upsetting and upset forging, flanging and nosing, shearing and forging and bolt blanks for heading.

Annealing

Induction heating is the ideal method of altering the character of metals for a special purpose. Annealing and its related process of tempering, normalising and stress relieving are prominent in



this category. In the case of annealing, one feature of the treatment is that it can be localised, while induction tempering can do in one minute what would require half-an-hour or more with conventional furnace heating.

Brazing, soldering and welding

Brazing and soldering by induction are the quickest and cleanest methods of joining metals together, and it is often beneficial to re-design the parts so that the fullest advantage can be taken of induction heating. Brazing can be used in the case of: carbide inserts for tools, tips for rock drills, parts for universal joints, etc., while the many applications of soldering are well-known. It was not until well into the present century that the age-old craft of welding became a positive aid to greater productivity. Induction welding produces a good, clean weld because oxidation is almost absent.

Miscellaneous Application

Induction heating can be profitably used for a large variety of purposes, including the fusion and hot pressing of powders, heating *in vacuo*, gas determination in metals, fusion of glass, chemical work and many other processes.

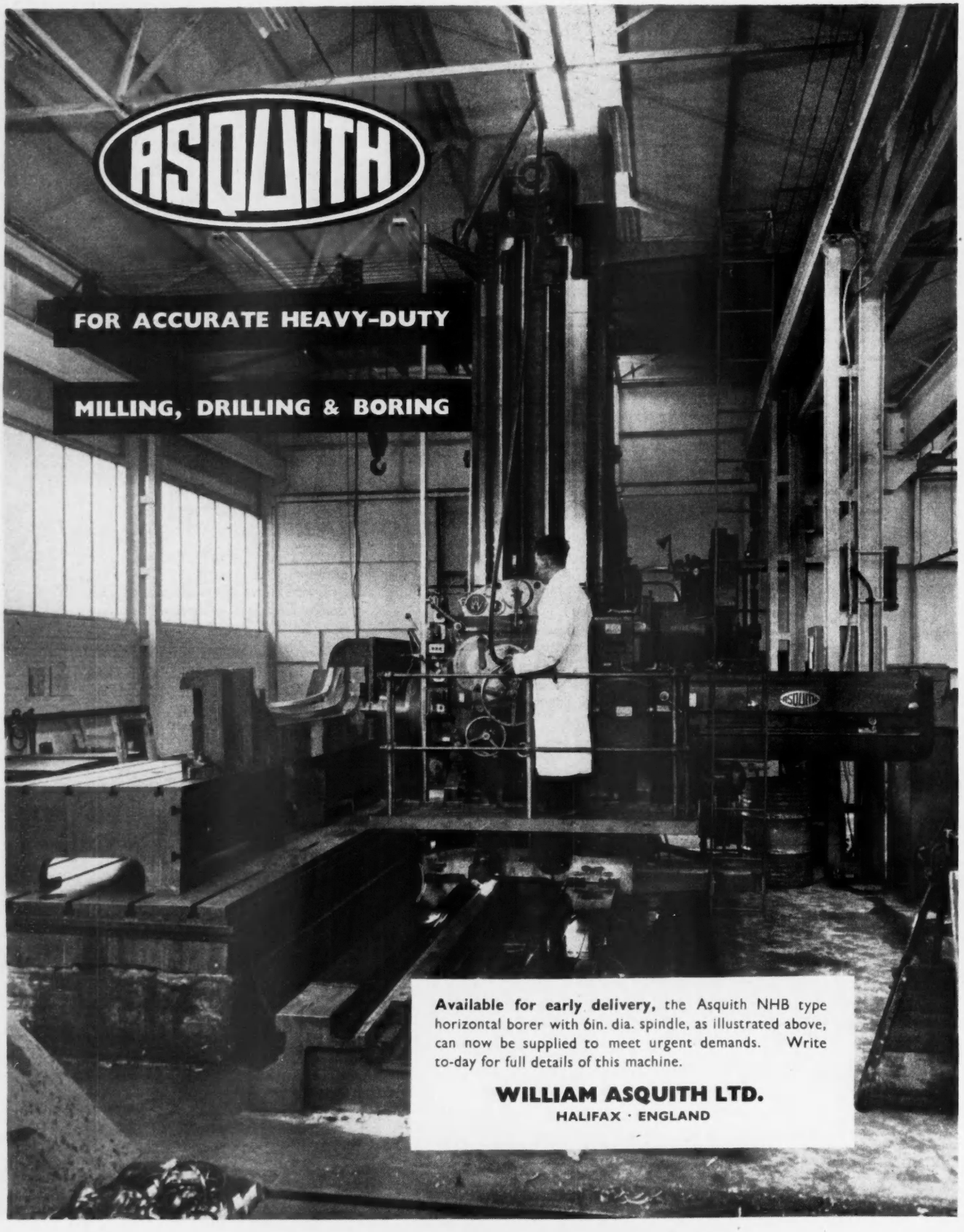
For further information, get in touch with your Electricity Board or write direct to the Electrical Development Association.

Excellent reference books are available on electricity and productivity (8/6 each or 9/- post free)—"Induction and Dielectric Heating" is an example.

E.D.A. also have available on free loan a series of films on the industrial use of electricity. Ask for a catalogue.

Issued by the Electrical Development Association, 2 Savoy Hill, London, W.C.2.

M

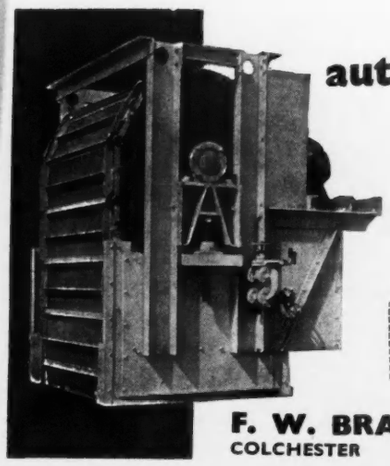

ASQUITH
FOR ACCURATE HEAVY-DUTY
MILLING, DRILLING & BORING
Available for early delivery, the Asquith NHB type horizontal borer with 6in. dia. spindle, as illustrated above, can now be supplied to meet urgent demands. Write to-day for full details of this machine.
WILLIAM ASQUITH LTD.
HALIFAX · ENGLAND

Sales & Service for .. **DRUMMOND-ASQUITH** ... the British Isles

DRUMMOND-ASQUITH (SALES) LTD., KING EDWARD HOUSE, NEW ST., BIRMINGHAM

'Phone: Midland 3431 (7 lines) 'Grams: Maxishape, Birmingham. Also at LONDON : 'Phone : Trafalgar 7224 (5 lines) and GLASGOW : 'Phone: Central 0922

A309

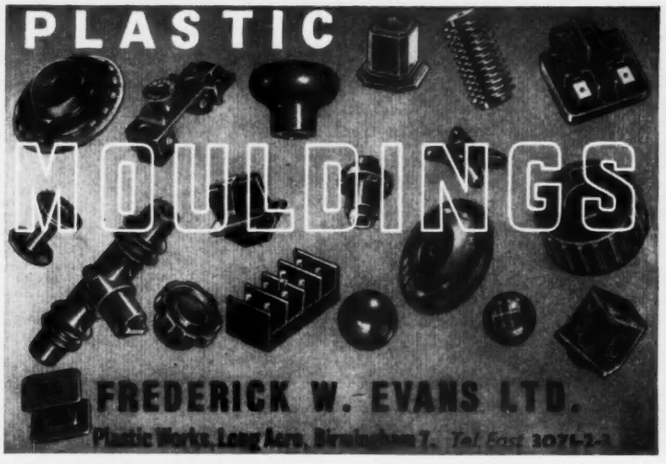


automatic screens

FOR CONDENSER COOLING
WATER - POWER STATIONS
WATERWORKS · FACTORIES
PAPERMILLS & TANNERIES

PUMPS FOR AIR
WATER & VACUUM

F. W. BRACKETT & CO. LTD.
COLCHESTER Telephone: 3958



Budenberg

Recording and indicating Tachometers for belt and direct drive.
For Turbines, Stationary engines and industrial use.

BUDENBERG GAUGE COMPANY LIMITED
BROADHEATH NR. MANCHESTER Telephone: ALTrincham 2617 (3 lines).
Regency House, 1-4, Warwick Street, LONDON, W.1. Telephone: GERrard 4822-3.
Telegrams: Pyrometer Piccy London. 62, Robertson Street, Glasgow, C.2.

High-duty Iron Castings up to 20 tons each

Apart from ferrous castings, we are specialists in the non-ferrous field. We make castings, from a few ounces to 10 tons in phosphor-bronze, gun-metal, aluminium-bronze, manganese-bronze and light alloys; precision machined bushes and bearings; high tensile aluminium-bronze castings; centrifugal-cast wheel blanks; shell moulded castings and chill cast rods and tubes. Continuous cast phosphor-bronze bars up to 12 feet lengths.

Illustrated is the bottom half of a 20-ton cast-iron Main Gear Case supplied to a large North Western engineering firm. 18 *ft.* 8 *in. long* x 7 *ft.* 2 *in. wide* x 3 *ft.* 8 *in. deep.*

This is a typical example of work carried out by Birkett, Billington & Newton Ltd. Difficult castings are our business.

HIGH-DUTY IRON CASTINGS
NON-FERROUS CASTINGS · PRECISION MACHINED BUSHES & BEARINGS

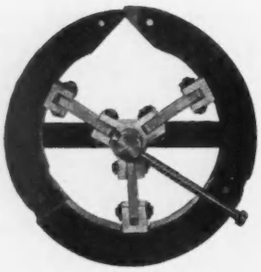
T. M. BIRKETT, BILLINGTON & NEWTON LTD
HANLEY AND LONGPORT, STOKE-ON-TRENT, ENGLAND
Head Office: HANLEY, Phone: Stoke-on-Trent 22184/5/6/7. LONGPORT, Phone: Newcastle, Staffs 51433/4.

TWINNER

PIPE EXPANDER

Accurately cut pipe bevels can only be achieved if the pipe end is perfectly round. All pipes have a degree of ovality and the Twinner Pipe Expander is designed to correct this. It is inserted in the pipe end and expanded to press out the walls to a truly round form—an oxy acetylene pipe cutter is then turned round the pipe to make the bevel.

Made to suit pipe sizes from 6" upwards.

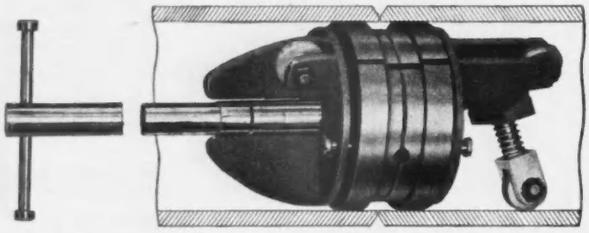


ENSURES TRUE PIPE BEVELS

TWINNER

INTERNAL PIPE ALIGNER

FOR THE ACCURATE ALIGNMENT OF PIPES FROM THE BORE



The aligner, in the contracted position, is propelled along the pipe internally in a position between the pipes to be butt welded. By operating a tommy bar on the end of extension tubes the aligner is expanded and presses out the pipe walls to their truly round form. Pressure holds the two pipes together in perfect alignment whilst the weld is laid—the aligner is then contracted and rolled along the pipe for the next weld.

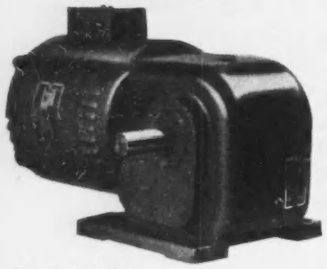
DONALD ROSS & Partners Ltd.

TWINNER WORKS, GATWICK ROAD, CRAWLEY, SUSSEX

Telephone: Crawley 25061-3 Telegrams: Twinner Crawley

Tib. 58

right-angled geared motors

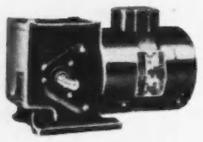


NECO right angle drive geared motors are units of compact design especially suitable for applications where space is limited. There is a wide range of output speeds and gearing is by worm, or worm and spur reduction, according to type of unit.

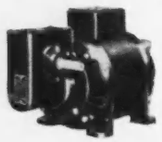
Patent applied for

NEW TYPE DR GEARED MOTOR

Type DR geared motors have ball bearing oil-immersed worm and wheel, with additional spur reductions. Motors of 1/6, 1/4, 1/3 or 1/2 h.p., for 3 phase, single phase or D.C. supplies, are fitted to the one-piece cast-iron gearbox. Final shaft speeds are from 15.6 r.p.m. to 305 r.p.m. Speeds down to 0.05 r.p.m. with a maximum torque of 100 lb.-ft. are available.



TYPE SW 1/8 h.p. motors, 3 phase, single phase, or D.C., final shaft speeds between 270 r.p.m. and 0.055 r.p.m. Maximum output torque is 25 lb.-ft. below 14.8 r.p.m.



TYPE W 1/8, 1/4 or 1/3 h.p., 3 phase, single phase, or D.C. Final shaft speeds from 270 r.p.m. down to 90 or 45 r.p.m. according to output.

NECO TRADE MARK

geared motors

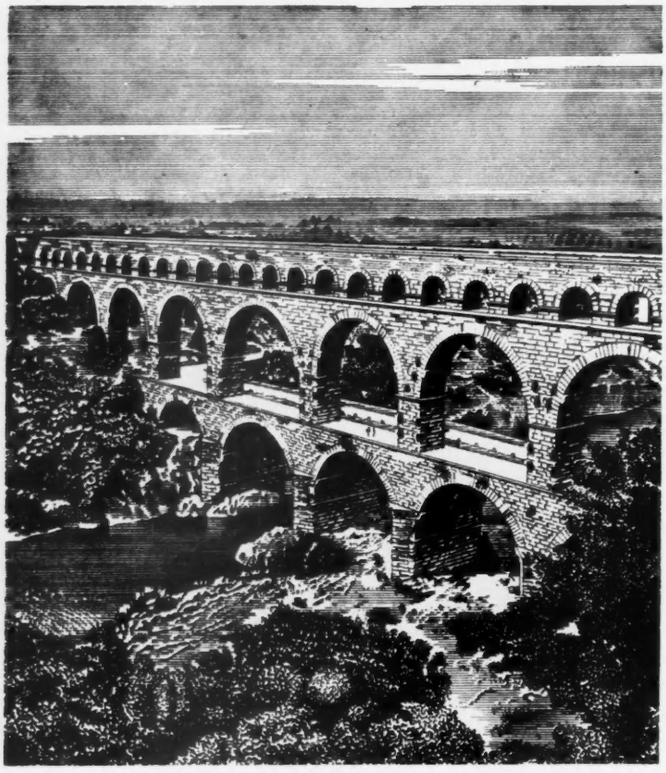
NECO GEARED MOTORS LTD

204 QUEENSTOWN ROAD · LONDON · S.W.8

Telephone: MACaulay 3211-4

Subsidiary of Normand Electrical Company Limited

THE PONT DU GARD AQUEDUCT



Wonders of the World

BUILT at Nimes, France, in 19 B.C., this Roman bridge was originally part of an aqueduct constructed to carry water from Uzès to Nimes. It is one of the noblest memorials of Roman architecture and an interesting feature is that the masonry is dry-jointed. Along the topmost tier runs the channel by which water was conveyed, the cement lining being of lime and terra-cotta. The structure is nearly 900 feet long and reaches a height of 160 feet. The lower arches each have a span of over 60 feet and now carry a modern road.

The Wonders of the Modern World will be chronicled by posterity and will reveal the indispensable contribution of steel tubes to these achievements.

WELLINGTON TUBE WORKS LTD

For Steel Tubes and Steel Tube Fabrication

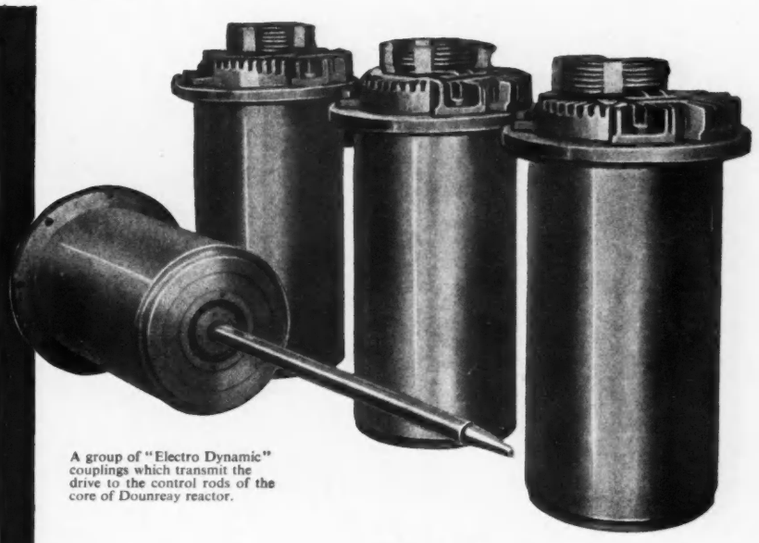
HEAD OFFICE: GREAT BRIDGE · TIPTON · STAFFORDSHIRE

At Dounreay...

The twelve groups of fuel rods used in the Reactor Core each have an "Electro Dynamic" magnetic coupling incorporated in the regulating mechanism which allows the drive to be transmitted through the reactor vessel without leakage of fission products. The 10 safety rods containing boron are similarly equipped.

The Electro Dynamic Coupling is being specified in increasing numbers for drives where a positive seal against the leakage of gases or liquids is important. The drive is transmitted to the driven member by magnetic lines passing through a hermetically sealed shroud which separates the two members. There are no slip rings or revolving parts other than the driving and driven members. The whole construction is of a simple and robust nature requiring no maintenance other than occasional lubrication of the ball bearings.

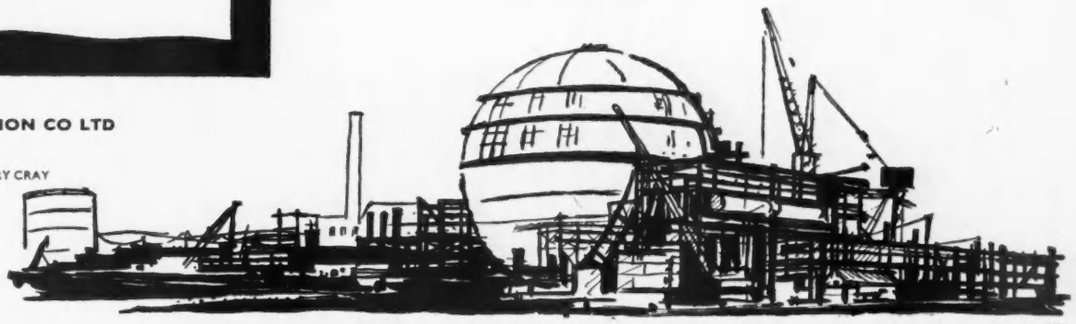
For nearly half a century E.D.C.C. have dealt with special requirements for electrical equipment and the Company's design engineers are always willing to discuss customers' specific problems on Electrical Revolving machinery and Control gear.



A group of "Electro Dynamic" couplings which transmit the drive to the control rods of the core of Dounreay reactor.

ELECTRO DYNAMIC CONSTRUCTION CO LTD

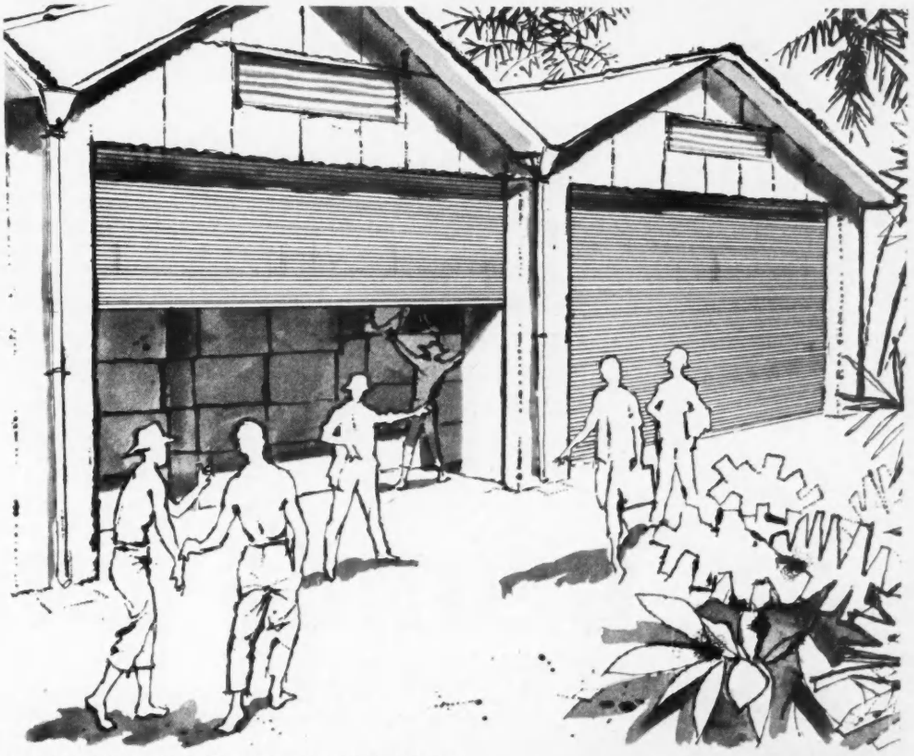
ELECTRO DYNAMIC CONSTRUCTION CO LTD
ST MARY CRAY KENT
Tel: ORPINGTON 27551 Grams: ELEDAMIC ST MARY CRAY
Control Gear Division:
Bridgwater Somerset Tel: Bridgwater 2882
Glasgow Office:
40 Houldsworth Street C3 Tel: Central 2620



P877

go up country

The year is closing. Now the fruits of a season's labour await shipment, protected meanwhile, behind steel shuttered doors against weather, scavenger and thief. Time and time again Brady Steel Rolling Shutter Doors provide the solution to problems of closing openings of unusual size and location. The use of only the highest grade materials and the considerable specialised experience that controls their construction guarantee them a trouble-free performance that makes them preferred both sides of the equator in both hemispheres. All the usual methods of operation are available, and doors can be designed to meet special requirements. Send for illustrated leaflet C35/SS353.



BRADY FOR EVERY OPENING: BRADY ROLLING DOORS IN STEEL, WOOD AND ALUMINIUM · SLIDING SHUTTER DOORS · GRILLES IN STEEL, ALUMINIUM OR NYLON · UP AND OVER DOORS · FIRE-PROOF DOORS . COLLAPSIBLE GATES · SLIDING DOOR GEAR · ALSO MANUFACTURERS OF BRADY LIFTS

G. Brady & Company Limited, Manchester, 4.
Telephone COLlyhurst 2797/8/9

BRADY
SHUTTERS ROLLING DOORS

THE DOORS COMMANDING THE WORLD'S LARGEST SALE—
London, Birmingham, Glasgow, Montreal, Port Credit, Hong Kong

HIRE PURCHASE TERMS

available for new and

SECONDHAND MACHINERY

★

Choose from our £3,000,000 stocks!

In offering H.P. Terms we are, of course, in the most exalted financial company nowadays. In fact, you'd be surprised how many concerns—small, large, and very large—are taking advantage of these very attractive terms of ours.

But what some people may not appreciate is that, as well as new, our

MODERN SECONDHAND & RECONDITIONED MACHINERY
SUCH AS:

MACHINE TOOLS, SHEET METAL MACHINERY, BOILERS, POWER PLANT, ELECTRICAL EQUIPMENT, HYDRAULIC PLANT, RUBBER & PLASTICS MACHINERY, PROCESS PLANT, CONTRACTORS' PLANT, MOBILE CRANES, LIFTING & MECHANICAL HANDLING EQUIPMENT, CONTRACTORS TOOLS

is available on favourable HIRE PURCHASE terms

GEORGE COHEN

SONS AND COMPANY LIMITED

THE 600 GROUP OF COMPANIES

WOOD LANE, LONDON, W.12. Tel: Shepherds Bush 2070 Grams: Omnipant, Telex London.

STANNINGLEY, NEAR LEEDS. Tel: Pudsey 2241 Grams: Coborn Leeds.

Sunbeam Road, LONDON, N.W.10. Tel: Elgar 7222

And at: Kingsbury (Nr. Tamworth) · Manchester · Glasgow · Swansea · Newcastle · Belfast · Sheffield · Southampton · Bath

CLASSIFIED ADVERTISEMENTS

AGENCIES · DIRECTORS · PARTNERSHIPS · SITUATIONS VACANT · EDUCATIONAL PATENTS · BUSINESS OPPORTUNITIES · MISCELLANEOUS · PUBLIC APPOINTMENTS BUSINESSES and PREMISES · TENDERS

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-.

Inch Rate. 48/- per single column inch and *pro rata*. 12 lines to 1 inch.

There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

AUCTION SALES · FOR HIRE · MACHINERY, etc., WANTED · SITUATIONS WANTED DRAWING AND DESIGN SERVICES · FOR SALE · SUB-CONTRACTING

Lineage Rate. 3/6 per line of approximately 6 words. Minimum 14/-.

Inch Rate. 42/- per single column inch and *pro rata*. 12 lines to 1 inch.

There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £22. ½-page £41 10s. Full page £78.

Series Discounts. For advertisements 1 inch and upwards. 6 insertions 5%. 13 insertions 10%. 26 insertions 15%.

Run-on and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

Advertisements for publication should be addressed to:—**Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.2.**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

NORWICH CITY COLLEGE AND ART SCHOOL

IPSWICH ROAD, NORWICH

Principal : FRANK BRIERS, B.Sc., D.Phil.(Oxon), F.R.I.C.

APPOINTMENTS

WANTED for 1st January, 1959 :

(a) LECTURER in ELECTRICAL ENGINEERING for teaching duties in Sandwich Diploma, Ordinary and Higher National Certificate and City and Guilds Electrical courses.

Applicants should possess University Degree, A.M.I.E.E., or equivalent, and have had teaching and suitable industrial experience.

Salary £1200 per annum rising by increments of £30 to £1350 per annum.

(b) TEACHER (Grade A) in MECHANICAL ENGINEERING for teaching duties mainly in Ordinary National Certificate and City and Guilds courses. There may be an opportunity for some teaching at a more advanced level.

Applicants must possess the Higher National Certificate in Mechanical Engineering or the Graduateship of the Institution of Mechanical Engineers and have had some industrial experience.

Salary according to Grade A of the Burnham Technical Scale (£475 per annum rising by £25 to £900 per annum, plus appropriate allowances).

Application forms, which may be obtained from the Director of Education, City Hall, Norwich, on receipt of a stamped, addressed envelope, should be returned to the Principal as soon as possible.

E8904

UNIVERSITY COLLEGE OF SWANSEA

RESEARCH FELLOWSHIP IN HEAT TRANSFER

Applications are invited for a FELLOWSHIP at the University College of Swansea, to pursue research into the mechanism of heat transfer from long pipes, carrying steam in the transition region from superheated to saturated. Facilities will be available for laboratory experiment and for field investigations on an industrial plant. The Fellowship is tenable for three years and the salary will depend upon qualifications and experience, but will be within the range of £700–£1000, together with F.S.S.U. benefits and family allowances.

Further particulars may be obtained from the Registrar of the University College of Swansea, Singleton Park, Swansea, by whom applications must be received not later than December 1, 1958. E8888

WIGAN AND DISTRICT MINING AND TECHNICAL COLLEGE

ASSISTANT GRADE B IN MECHANICAL ENGINEERING

Applications are invited for a post as ASSISTANT GRADE B IN MECHANICAL ENGINEERING. Duties will commence as soon as possible. Candidates should hold a degree in Mechanical Engineering, or equivalent qualification, have practical experience in industry or teaching. Salary scale £650 by £25 to £1025 per annum with additions for qualifications and experience.

Further particulars and application form will be sent by the undersigned. Last date for receipt of applications : Friday, 7th November, 1958.

E. C. SMITH,
Principal.

E8916

UNIVERSITY OF BELFAST

CHAIR OF MECHANICAL ENGINEERING

The Senate of The Queen's University of Belfast invites applications from 1st October, 1959 (following the retirement of Professor F. V. Warnock). Salary £2600 plus F.S.S.U. Applications should be submitted by 30th November, 1958.—Further particulars from G. R. Cowie, M.A., LL.B., J.P., Secretary. E8933

PUBLIC APPOINTMENTS

NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE

BURTON STREET, NOTTINGHAM

Principal : D. A. R. CLARK, M.Sc.(Tech), M.I.Mech.E.

LECTURERS

Applications are invited for the posts listed below, the successful applicants to commence duty as soon as possible.

The College is, in the main, concentrating on Advanced work and on account of its substantial new building, which came into full operation in September, 1958, ideal conditions for the development of such work are given. There is a fairly large volume of research work being done in most departments and staff are encouraged to undertake such work either for publications or higher degrees. Staff are allowed to undertake consultancy work for industry.

DEPARTMENT OF MECHANICAL ENGINEERING

1. SENIOR LECTURER IN MECHANICS AND DESIGN OF MACHINES to teach Theory of Machines and Mechanical Engineering Design to Diploma and Engineering Degree level. An ability to teach Control Engineering would be an added recommendation.

2. SENIOR LECTURER IN STRENGTH OF MATERIALS to teach this and associated subjects to Diploma and Degree level. An ability to teach Plastics Technology would be an added recommendation.

3. LECTURER IN APPLIED THERMODYNAMICS to teach the subject to Higher National Certificate level.

4. LECTURER IN PRODUCTION ENGINEERING with particular reference to Machine Tools. The person appointed will be expected to teach Production Engineering subjects to Diploma level and the ability to initiate and undertake research in Production Engineering topics would be an added recommendation.

5. LECTURER IN PRODUCTION ENGINEERING to teach Production Engineering subjects to Higher National Certificate level. Experience in Automatic Machining methods would be an added recommendation.

An Engineering Degree or Associate Membership of the appropriate Institution is essential for the above five posts.

IT IS ESSENTIAL FOR CANDIDATES APPLYING FOR ALL OF THE ABOVE POSTS TO HAVE UP-TO-DATE INDUSTRIAL EXPERIENCE.

Salaries in accordance with the Burnham Technical Scale as follows :

Senior Lecturer : £1350 rising by annual increments of £50 to £1550 per annum. A salary above the minimum will be paid in approved cases.

Lecturer : £1200 rising by annual increments of £30 to £1350 per annum. A salary above the minimum will be paid in approved cases.

Further particulars and form of application may be obtained from the Principal, to whom completed forms should be returned not later than 7th November 1958. E8919

NORTHAMPTON COLLEGE OF ADVANCED TECHNOLOGY

ST. JOHN STREET, LONDON, E.C.1.

LECTURERS

Applications are invited for the following appointments, to commence in January, 1959, or soon thereafter :

(a) LECTURERS in MECHANICAL ENGINEERING or CIVIL ENGINEERING. Applicants should be qualified academically and by industrial experience to teach to the standard of the London Degree in Engineering and Diploma in Technology. Scale : £1236 rising to £1398 p.a.

(b) ASSISTANT LECTURERS for the above courses ; one required mainly for ENGINEERING DRAWING. Scale : £761 rising to £1148 p.a., with additions for training and industrial or teaching experience.

Further particulars and form of application are obtainable from the Secretary to whom applications should be sent by 7th November.

J. S. TAIT, Ph.D., B.Sc.(Eng.), A.R.T.C., M.I.E.E., M.I.Mech.E.,
Principal.

E8915

PUBLIC APPOINTMENTS

UNIVERSITY OF SYDNEY

AUSTRALIA

SENIOR LECTURESHIP IN CIVIL ENGINEERING

Applications are invited for the above position. Candidates should have an Honours Degree in Engineering and have been engaged in teaching or research in the subject Materials. Preference will be given to applicants having additional qualifications in either Metallurgy or Metal Physics.

The salary for a Senior Lecturer is within the range £A2200 by £80 to £2600 per annum, plus cost of living adjustment, and will be subject to deductions under the State Superannuation Act. The commencing salary will be fixed according to the qualifications and experience of the successful applicant.

Under the Staff Members' Housing Scheme in cases approved by the University and its Bankers, married men may be assisted by loans to purchase a house.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1.

The closing date for the receipt of applications, in Australia and London, is 29th November, 1958.

E8934

BRIGHTON TECHNICAL COLLEGE

Principal : G. E. WATTS, M.A., Ph.D.(Cantab), B.Sc.(Lond.), F.R.I.C.

LECTURER IN HYDRAULICS

Required : LECTURER IN HYDRAULICS to teach subject to degree and professional levels. Applicants should hold degree in Engineering. Corporate membership of Institution of Civil Engineers an advantage. Teaching and industrial or research experience desirable.

Salary £1200 by £30 to £1350, with increments for approved industrial, professional or research experience.

Further particulars and forms of application from the undersigned, to be returned to the Principal, Brighton Technical College, Brighton 7, as soon as possible.

W. G. STONE,
Director of Education.

54, Old Steine,
Brighton. E8943

QUEEN'S UNIVERSITY OF BELFAST

SENIOR LECTURESHIP IN MECHANICAL ENGINEERING

The Senate of The Queen's University of Belfast invites applications for a SENIOR LECTURESHIP IN MECHANICAL ENGINEERING from 1st April, 1959. Salary range £1500 by £100 to £2000 plus contributory pension rights under the F.S.S.U. Initial placing at any point on the salary scale will depend on qualifications and experience. Applications should be received by 1st December, 1958.—Further particulars may be obtained from G. R. Cowie, M.A., LL.B., J.P., Secretary. E8949

SURREY EDUCATION COMMITTEE

WIMBLEDON TECHNICAL COLLEGE, GLADSTONE ROAD, S.W.19.

LECTURER IN MECHANICAL ENGINEERING

LECTURER required in January, 1959, to teach MECHANICAL ENGINEERING subjects to Higher National Certificate level with particular reference to Mathematics. Applicants should be graduates with suitable teaching and industrial experience. Salary, Burnham Scale, £1200 by £30 to £1350, plus London Allowance.

Application form and further particulars may be obtained from the Principal.—Applications required within two weeks of date of advertisement. E8937

PUBLIC APPOINTMENTS

NATIONAL COAL BOARD

NORTH STAFFORDSHIRE AREA

APPOINTMENTS

Applications are invited for the following positions in the Central Engineering Workshop, situated at Hem Heath Colliery in the North Staffordshire Area of the West Midlands Divisional Coal Board :

(a) NS(58)125. A PLANNING ENGINEER to assume control of the planning and progress sections. Applicants should have a proved engineering background and comprehensive experience of modern planning and production control techniques, and should for preference hold a Higher National Certificate or its equivalent in Mechanical or Production Engineering with Electrical endorsement.

(b) NS(58)126. An ENGINEER to assume control of the inspection section. Applicants should have a proved engineering background with extensive experience of mechanical and electrical testing procedures and some knowledge of gauging techniques, and be able to prepare and maintain inspection standards. A thorough understanding of the application of fits and limits is essential, and applicants should, for preference, hold a Higher National Certificate in Mechanical Engineering with Electrical endorsement.

The Works will employ about 200/250 personnel who will be engaged mainly upon the overhaul and reconditioning of mining machinery. It has an overhaul and reconditioning shop for mining machinery, plating, construction, blacksmith and heat treatment shops, locomotive overhaul shop, machine, electrical and carpenter's shops and in all cover a floor area of about 75,000 square feet.

Both posts attract a salary in the range £900–£1400 per annum and are superannuable.

Application forms, obtainable from the Area Staff Manager, National Coal Board, 72, Leek Road, Stoke-on-Trent, should be returned not later than 4th November, 1958. Please quote the appropriate reference number. E8927

CIVIL SERVICE COMMISSION

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

SENIOR PRINCIPAL SCIENTIFIC OFFICER

SENIOR PRINCIPAL SCIENTIFIC OFFICER required by Department of Scientific and Industrial Research. Pensionable appointment for man or woman for newly created post of Scientific Attache to H.M. Embassy in Moscow. To advise H.M. Ambassador on scientific matters and report on Soviet scientific and technical development. Posting to Moscow for at least two years in the first instance.

Qualifications : 1st or 2nd Class Honours Degree in Scientific or Engineering subject, or equivalent qualifications. Wide scientific and technical interests and experience. Good working knowledge of Russian, or ability to learn it quickly, essential, Knowledge of French or German an advantage. Salary scale (men) £2150–£2350, plus allowances. Promotion prospects.

Write, Civil Service Commission, 30, Old Burlington Street, London, W.1, for application form, quoting S4895/58. Closing date, 11th November, 1958. E8884

ADMINISTRATIVE COUNTY OF LEICESTER

COUNTY ARCHITECT'S DEPARTMENT

MECHANICAL ENGINEER

MECHANICAL ENGINEER £750–£1030. Initial salary according to qualifications and experience. Candidates who must have had good drawing office experience should be capable of assessing and advising on the qualities of various mechanical appliances, be experienced in planning the installation of laundry machinery and mechanical plant, able to supervise and instruct maintenance engineers and have a knowledge of the design of heating schemes. A.M.I.Mech.E. or possession of H.N.C. an advantage. Temporary lodging allowance and removal expenses may be paid to a married man.—Apply by 1st December, 1958, on forms obtainable from County Architect, 123, London Road, Leicester. E8935

Classified Advts. continued on page 104

PUBLIC APPOINTMENTS

STAFFORDSHIRE COUNTY COUNCIL

COUNTY ARCHITECT'S DEPARTMENT

ASSISTANT HEATING ENGINEERS

Appointment of ASSISTANT HEATING ENGINEERS: Grade A.P.T. III (£845–£1025). Grade A.P.T. IV (£1025–£1175).

Applications are invited for the above posts from Heating and Ventilating Engineers; applicants for Grade A.P.T. IV must have had considerable experience and be Corporate Members of the Institution of Heating and Ventilating Engineers, or hold equivalent qualification.

The appointment will be subject to:

(a) The National Scheme of Conditions of Service.

(b) The Local Government Superannuation Acts and the passing of a medical examination.

The County Council are prepared to grant a lodging allowance of 35s. per week to married applicants maintaining a home outside the geographical County for a period of 6 months; also 2nd class rail travel home every second month during the initial 6 months. The Council are also prepared to give consideration to the granting of financial assistance to appropriate cases towards removal expenses.

Forms of application may be obtained from the County Architect, Green Hall, Lichfield Road, Stafford, and should be returned as soon as possible.

T. H. EVANS,
Clerk of the County Council.

E8917

COUNTY BOROUGH OF PRESTON

PORT OF PRESTON AUTHORITY

ENGINEERING ASSISTANT

Applications are invited for the post of ENGINEERING ASSISTANT in the Chief Engineer's Department of the Port of Preston Authority. Applicants should have passed the final examination of the Institution of Civil Engineers or equivalent, and have good general civil engineering experience, but experience of Dock and Harbour work is not essential.

The appointment will be to the Special Grade for Engineering Assistants (£750–£1030 per annum); it will be subject to the Local Government Superannuation Acts and to the passing of a medical examination.

Application forms may be obtained from the undersigned, to whom they should be returned not later than 11th November, 1958.

W. E. E. LOCKLEY,
Town Clerk.

Municipal Building,
Preston.

E8891

BEXHILL CORPORATION

WATER UNDERTAKING

ENGINEERING ASSISTANT

Appointment to be made within Special Grade, £750 to £1030.

Applications are invited for the above appointment from suitably qualified persons, and "Forms of Application" may be obtained from the Water Engineer and Manager, Town Hall, Bexhill-on-Sea.

The appointment is subject to:

(1) National Scheme of Conditions of Service.

(2) The Local Governments Superannuation Acts, and

(3) A satisfactory medical examination.

Closing date for receipt of applications October 31st, 1958.

EDWARD SMITH,
Town Clerk.

E8837

CIVIL SERVICE COMMISSION

MECHANICAL AND ELECTRICAL ENGINEERS

Pensionable posts for men and women normally under 35 on 1st September, 1958. Applicants must normally have Degree in Engineering or Physics (or Dip. Tech. for some posts) or have passed examinations necessary for A.M.I.Mech.E., A.M.I.E.E., A.F.R.Ae.Soc., &c. Exceptionally, evidence of high professional attainment acceptable in lieu. Practical training and experience required but graduates without practical experience acceptable for some posts. Men's starting salary from £755 (lower if under 25) to £1085. Maximum (London) £1250. Promotion prospects.

Write, Civil Service Commission, 30, Old Burlington Street, London, W.1, for application form, quoting S851/58. Closing date, 18th November, 1958. Earlier applicants may be interviewed before that date.

E8882

WEST MANCHESTER HOSPITAL MANAGEMENT COMMITTEE

BRIDGEWATER HOSPITAL

ASSISTANT ENGINEER

ASSISTANT ENGINEER required based at Bridgewater Hospital, Green Lane, Patricroft, to maintain services at Bridgewater and Eccles Hospitals, under the direction of the Suprintendent Engineer. Candidates must have completed an apprenticeship or have otherwise acquired a sound practical training in mechanical engineering and should hold a recognised technical qualification. Salary scale £555–£675. National Health Service conditions. No housing accommodation available.—Application forms obtained from Group Secretary, Park Hospital, Davyhulme, Manchester, to be received within ten days of the appearance of this advertisement.

E8945

MINISTRY OF LABOUR AND NATIONAL SERVICE

ROYAL NAVAL SCIENTIFIC SERVICE

APPOINTMENTS

Royal Naval Scientific Service requires SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS for Establishments in London area, Baldock, Portsmouth, Portland, Poole, Greenock and Rosyth. Main requirements are about 25 vacancies for PHYSICISTS, ELECTRONIC ENGINEERS and MATHEMATICIANS in areas specified. The following particular vacancies also exist: MECHANICAL ENGINEER, for work on gas turbine problems in the London area. MECHANICAL ENGINEER, for work on design and development of U/W devices in Portland area. METALLURGISTS for Rosyth and Poole. CHEMISTS (Physical and Inorganic), for Poole area, Baldock and London. Candidates must normally be natural born British subjects of natural born British parents, with at least First or Second Class Honours Degrees or equivalent high professional attainments. S.S.O.'s must have had at least three years' post-graduate experience and be not less than 26 years of age. Salaries: (men) S.S.O. £1190–£1410; S.O. £635–£1110 (London)—somewhat lower in provinces. Appointments unestablished (with F.S.S.U. benefits), but opportunities may occur for those between ages of 21 and 32 to compete for established posts.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting A98/8A.

E8879

GLANTAWE HOSPITAL MANAGEMENT COMMITTEE

SWANSEA HOSPITAL, SWANSEA

SENIOR ENGINEER

Applications are invited for the appointment of SENIOR ENGINEER at the above hospital. Candidates must have served an apprenticeship in mechanical engineering and possess a sound knowledge of the principles and practices of the efficient operation of steam boiler plant and engineering services generally.

Possession of one of the following qualifications is essential:

1st Class Certificate of Competency in Marine Engineering or equivalent Naval certificate.

City and Guilds Full Technological Certificate in Plant Engineering (1st Class) (from 1947) or approved equivalent qualification.

Conditions of service and salary will be as laid down by the Whitley Council, i.e. £700 p.a. by £25 (3) by £30(2) to £835 p.a.

The appointment is subject to one month's notice on either side.

Forms of application are obtainable from the undersigned at Glantawe H.M.C., St. Helen's Road, Swansea, to whom they should be returned not later than 8th November, 1958.

T. E. JONES,
Group Secretary.

E8918

TYNE IMPROVEMENT COMMISSION

CHIEF ENGINEER'S DEPARTMENT

CIVIL ENGINEERING ASSISTANT

Applications are invited for the appointment of a CIVIL ENGINEERING ASSISTANT in the Chief Engineer's Department at a salary within the range £590 to £845—the commencing salary will be according to qualifications and experience.

Applicants must possess Ordinary National Certificate (Civil Engineering) or higher qualifications, and have had good general experience in civil engineering work.

The appointment will be superannuable and subject to the passing of a medical examination.

Applications, stating age, education, present and previous appointments, and giving full particulars of qualifications and experience, together with the names of three referees under whom applicants have served, should be sent to the undersigned in envelopes endorsed "Civil Engineering Assistant," not later than the 10th November, 1958.

R. N. EGGLETON,
Secretary.

Bewick Street,
Newcastle upon Tyne, 1.
20th October, 1958.

E8955

GREAT YARMOUTH WATERWORKS COMPANY

ASSISTANT PUMPING AND TREATMENT SUPERINTENDENT

Applications are invited for the above appointment. Salary (Miscellaneous Grade IV) £565–£625.

Candidates must be skilled fitters with experience in maintenanse and repair of large stationary oil engines, electrically driven pumps, &c., and be able to deputise for the Superintendent and to assist in the operation and control of the Treatment Works.

The successful applicant will be required to join the Company's Superannuation scheme and to reside at a house provided rent free by the Company at Ormesby St. Michael, Great Yarmouth.

Full particulars of the post and conditions of service may be obtained from the undersigned.

S. A. S. WALTON,
O.B.E., A.M.I.C.E., M.I.W.E.
Engineer.

84, York Road,
Great Yarmouth.

E8911

MECHANICAL INSPECTOR

GOVERNMENT OF HONG KONG FIRE BRIGADE

MECHANICAL INSPECTOR, CLASS II, required by the Government of Hong Kong Fire Brigade on probation for 3 years to pensionable establishment. Normal tour 3½ years. Superannuation rights of serving U.K. Fire Officers cannot be preserved. Salary (including expatriation pay) equivalent to £903, rising to £1466 a year. Additional temporary allowance between £30 and £360 a year payable according to salary and dependants. Commencing salary according to qualifications and experience. Free passages. Liberal leave on full salary. Candidates, of robust physique, must have served a full apprenticeship to motor engineering. They should have a sound knowledge of electric and automobile engineering, including petrol and diesel engines, and hydraulics, and have served for at least 3 years with a professional Fire Brigade as Engineer. They must be fully conversant with maintenance and repair of modern fire appliances, pumps, fire equipment, fire engines, fire escapes, turntable ladders, &c., and be capable of taking charge of the Fire Brigade workshop and workshop staff.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience, and quote M2A/42612/EH.

E8957

BRITISH STANDARDS INSTITUTION

TECHNICAL STAFF

The B.S.I. invites applications from engineers to join the TECHNICAL STAFF of the Institution. The technical staff are responsible for the work of the Institution in the preparation of British Standards in co-operation with the various sections of industry, and are required to plan and progress the work.

Applicants should have a University Degree or equivalent professional qualification in Mechanical or Electrical Engineering. Experience with instrumentation would be an advantage.

There are three grades of appointment, with an overall salary range up to £2000; applications are invited for the grade which has at present a maximum salary of £1250, the starting figure being dependent on individual qualifications and experience. The posts are pensionable.

Apply to the Establishment Officer, B.S.I., 2, Park Street, London, W.1.

E8953

BRITISH RAILWAYS RESEARCH DEPARTMENT

DERBY

SCIENTIFIC OFFICER

Vacancy for SCIENTIFIC OFFICER (Grade 2) in Engineering Division at Derby.

Candidates should have good degree but previous research experience not essential. Position is for study of application of mathematics to solution of engineering problems.

Salary £665 to £985 according to qualifications or experience.

Superannuation and travel facilities.

Applications, stating age, experience, &c., to:
Director of Research,
British Transport Commission,
British Railways Division,
222, Marylebone Road,
London, N.W.1.

E8944

COUNTY BOROUGH OF EAST HAM

ASSISTANT ENGINEER (MECHANICAL) GRADE III £845–£1025

London Weighting is paid in addition. Salary in excess of the minimum may be paid according to qualifications and experience.

A subsistence allowance may be granted over a reasonable period to the person appointed if unable to obtain suitable housing accommodation, necessitating the maintenance of two homes.

Further details and application forms returnable by 7th November, 1958 from the Town Clerk, Town Hall, E.6.

E8939

ATOMIC ENERGY RESEARCH ESTABLISHMENT

HARWELL

A TECHNICAL OFFICER

(with apprenticeship or equivalent training) is required to supervise the operation of a contractor's site workshop making and erecting a wide range of "one off" jobs of a general engineering nature, using normal machine tools, welding and sheet metal working equipment. Technical and administrative ability in the control of the work of contractors will be required.

Salary: £875–£1050 (Tech. II).

Send Postcard to the Group Recruitment Officer (1170/25), U.K.A.E.A., A.E.R.E., Harwell, Berks., for details.

E8894

AIR MINISTRY

requires

ASSISTANT SUPERINTENDENTS

in

REINFORCED CONCRETE and

STRUCTURAL STEEL SECTIONS

of

LONDON DESIGNS OFFICE

Candidates must have

(*a*) a sound specialist knowledge and experience of all general types of reinforced concrete construction and/or steel frameworks. At least ten years as a reinforced concrete and/or steelwork DESIGN/DRAUGHTSMAN with experience in the design of mass and heavy reinforced concrete structures and/or steel frameworks, preferably including underground works;

(*b*) design ability and judgment necessary to direct and guide the work of a team of designers;

(*c*) the ability to discuss structural problems and schemes at meetings and prepare reports, also obtain site information as required;

(*d*) minimum technical qualifications H.N.C., A.M.I.Struct.E. or equivalent.

Salary within the range of £1280 to £1485, 4–6 weeks leave according to length of service.

Applications in writing, normally from natural born British subjects, stating age, qualifications and experience, including details of employment, responsibilities and type of work done to Air Ministry, C.E.4b, Room 421, Cornwall House (H4), Stamford Street, London, S.E.1.

E8883

TENDERS

BISHOP'S STORTFORD URBAN DISTRICT COUNCIL

SEWERAGE

CONTRACT NO. 2A

TENDERS are invited on a fixed price basis in accordance with the Ministry of Housing and Local Government Circular No. 31/57, for the CONSTRUCTION of SEWERAGE and a SEWAGE PUMPING STATION at Bishop's Stortford.

The sewerage will consist of approximately 1300 linear yards of 21in. to 36in. diameter concrete pipe sewer, together with precast concrete manholes, and will include a river crossing.

The sewage pumping station will have a reinforced concrete substructure inside a steel sheet piled cofferdam approximately 25ft. deep, and a prefabricated superstructure.

General conditions of contract, specification, bills of quantities and drawings may be obtained from the Council's Consulting Engineers, Messrs. J. D. and D. M. Watson, M.M.I.C.E., 67, Tufton Street, Westminster, S.W.1, on and after 20th October, 1958, on payment of a deposit of ten guineas, refundable only to contractors who submit bona fide Tenders and return all documents and drawings on or before the last day for receipt of Tenders. Deposit cheques should be made payable to J. D. and D. M. Watson or order.

The Council do not bind themselves to accept the lowest or any Tender.

Tenders must be returned in envelopes which do not bear any name or mark indicating the sender, endorsed "Tender for Contract No. 2A," and delivered at the office of the undersigned by noon on 22nd November, 1958.

G. NORMAN DRINKWATER,
Clerk of the Council.

Bishop's Stortford Urban District Council,
The Council House,
Bishop's Stortford, Herts.

E8876

MIDDLESEX COUNTY COUNCIL

SUPPLY OF LUBRICATING OIL

TENDERS invited for SUPPLY of LUBRICATING OIL for use in diesel power plant at Mogden Works, Isleworth, during period April 1st, 1959, to March 31st, 1962. Approximate quantity required, 12,000 gallons per annum, delivered in bulk. Tender forms from Chief Engineer, Main Drainage Department, P.O. Box No. 7, Isleworth.

Tenders to be delivered to the Clerk, Middlesex Guildhall, S.W.1, by 17th November. The County Council does not bind itself to accept the lowest or any Tender. Canvassing disqualifies.

E8886

TENDERS

COMMISSIONERS FOR THE PORT OF CALCUTTA

THREE DIESEL-HYDRAULIC SHUNTING TYPE LOCOMOTIVES WITH SPARES

TENDERS are invited from manufacturers for the SUPPLY of THREE DIESEL-HYDRAULIC SHUNTING TYPE LOCOMOTIVES with SPARES.

Tender forms and specifications may be obtained from Messrs. Rendel, Palmer and Tritton, Consulting Engineers and London Agents to the Commissioners, upon payment of £1 10s. 0d. per copy, and at the office of the Chief Mechanical Engineer to the Commissioners for the Port of Calcutta, 8, Garden Reach Road, Kidderpore, Calcutta–23, India, on production of a receipt for Rs. 20/– for each copy, from the Commissioners' Treasurer at 15, Strand Road, Calcutta. This amount is not refundable under any circumstances.

Tenders should be submitted in triplicate, in sealed covers superscribed "Diesel Locomotives."

The original, with a copy, should be addressed to Messrs. Rendel, Palmer and Tritton, 125, Victoria Street, Westminster, London, S.W.1, and the second copy should be addressed to the Chief Mechanical Engineer, 8, Garden Reach Road, Kidderpore, Calcutta–23, India, so as to reach them not later than 10 a.m. G.M.T. in London and 3 p.m. I.S.T. in Calcutta on Friday, the 19th December, 1958.

These tenders will be opened publicly half an hour later on the same day at both the above premises in the presence of those tenderers who may wish to attend. E8956

EDUCATIONAL

UNIVERSITY COLLEGE LONDON (Gower Street, W.C.1).—FOUR LECTURES by Mr. J. F. Coales (Engineering Department, Cambridge) on "Automatic Control," will be given on Tuesdays and Thursdays, 4th, 6th, 11th, 13th November, at 5.30 p.m. Admission Free, without ticket.—E. A. L. GUETERBOCK, Secretary. E8885 E

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams., and Technical Divisions from Elementary to Degree standard. Approximately 95 per cent. successes. 144-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

UNIVERSITY OF LONDON KING'S COLLEGE invites applications for the LEVERHULME STUDENTSHIP IN CHEMICAL ENGINEERING, value £500 a year for one or two years, from 1st January, 1959. Applicants must have a post-graduate diploma in Chemical Engineering or equivalent qualifications.—Forms from the Registrar, King's College, Strand, W.C.2, whom completed applications must reach by November 17th. E8952 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED

A DESIGN AND DETAIL MECHANICAL DRAUGHTSMAN, aged 30/35, is required by Bonded Fibre Fabric Limited, Bath Road, Bridgewater, Somerset. A good practical background is essential: O.N.C. desirable but not essential.—Write to the Personnel Officer, stating relevant details. E8908 A

BOOKS and PUBLICATIONS

PITMAN
technical
books

Parker St., Kingsway,
London, WC2

PRACTICAL ENGINEERING METROLOGY

By K. W. B. Sharp, B.Sc., etc. This is one of the few books to cover the basic principles of the subject. It deals chiefly with the fundamentals on which the student can build, covers methods, instruments and accuracy, as well as examination requirements. 30/– net.

AN ELECTRONIC ORGAN FOR THE HOME CONSTRUCTOR

By Alan Douglas, M.I.R.E., etc. This do-it-yourself book gives straightforward instructions for building an inexpensive electronic organ. Detailed step-by-step instructions are given for this easily transportable instrument, as well as a complete list of materials and their suppliers. 15/– net.

ENGINEERING ECONOMICS

Book I—ELEMENTS OF INDUSTRIAL ORGANIZATION

By T. H. Burnham, B.Sc. (Hons.), B.Com., etc., and G. O. Hoskins, B.Com., etc. 6th Edition. 21/– net.

Book II—FACTORY ORGANIZATION AND MANAGEMENT

By T. H. Burnham, B.Sc. (Hons.), B.Com., etc., and D. H. Bramley, M.I.Mech.E., etc. 7th Edition. 25/– net.

Two standard works which are completely up to date. Together they cover the I.Mech.E. syllabus in Industrial Administration.

"A complete library in two volumes.."

KEMPE'S

Engineers Year-Book

Edited under the direction of the Editor of "The Engineer"

1959 (64th Edition)

WILL BE PUBLISHED IN DECEMBER

82/6 (plus postage 2/6)

★ **3,000 pages covering modern theory and practice in all branches of engineering. No other single publication devoted to engineering covers a comparable range of subjects so concisely.**

ORDER YOUR COPY NOW

Obtainable direct from the publishers or through your local booksellers

Kempe's Engineers Year - Book

28 Essex Street, Strand, London, W.C.2

Telephone: Central 6565

SITUATIONS VACANT

A GENERAL MANAGER is required by a Rubber Company specialising in high-grade Mechanical Mouldings, Rubber to Metal Bonding, and a wide range of associated products for the Automobile, Marine, Civil, and Mechanical Engineering Industries. Extensive engineering and factory administrative experience is essential.—Applications should be submitted to the Managing Director, BOX B.181, c/o Streets, 110, Old Broad Street, E.C.2. E8909 A

AN ADDITIONAL DESIGNER DRAUGHTSMAN REQUIRED, for small City office, mainly concerned with coal handling plant for modernising retail depots. What is wanted is someone who can extend considerable experience gained by company in this field.—Apply in writing to Charrold, Ltd., 40, Trinity Square, London, E.C.3. E2139 A

APPLICATIONS, which will be treated with strict confidence, are invited for the position of SALES MANAGER with a Northern Firm of Constructional Enginers. Consideration will be given to men with a technical background who have held a similar position with established firms in the structural engineering industry. Apply.—BOX No. E8946, "The Engineer." A

APPLICATIONS INVITED FROM ENGINEERS experienced in various phases of works engineering for responsible posts at food factories. These are staff positions and salaries are commensurate with duties.—Write in confidence to the Secretary, Crosse and Blackwell, Ltd., 20, Soho Square, London, W.1. E8928 A

BRITISH PETROLEUM COMPANY, LTD., has a vacancy in its London Drawing-Office for a MECHANICAL ENGINEER, to take charge of company standard drawings and drawing-office technical data and be responsible for a section of draughtsmen engaged on general and standards work. Applicants, aged 30–45, must hold at least H.N.C. in Mechanical Engineering and have served an engineering apprenticeship, including shop experience, followed by several years in or attached to a drawing-office. A good basic general engineering background is required, with sound knowledge of oil refinery process plant and equipment and familiarity with the application of British and American engineering standards. Salary according to qualifications, age and experience. Non-contributory pension fund, luncheon club, assisted house purchase scheme, removal expenses and settling-in allowance payable in certain cases.—Write, giving full details, quoting H.4598, to BOX 5881, c/o 191, Gresham House, E.C.2. E8941 A

BRITISH PETROLEUM COMPANY, LTD., has a vacancy in WEST AFRICA for an ENGINEER. Applicants, aged 25–35, must hold at least H.N.C. and have had sound workshops training with a good knowledge of automotive/structural equipment and appliances and some drawing-office experience. The work is concerned with the maintenance and operation of oil marketing facilities, including pump/tank installations, bulk petroleum vehicles, &c., and calls for a man with sound common sense and initiative, able to use ingenuity in surmounting difficulties with the limited plant and equipment available. Attractive salary, good leave arrangements, kit allowance, free medical attention. Pension scheme, free passages out and home.—Write, giving full details, quoting Ref. H.4564, to BOX 5874, c/o 191, Gresham, House, E.C.2. E8896 A

CHIEF DRAUGHTSMAN.—Applications are invited for a responsible man to take charge of a small Chemical Engineering Drawing Office in London. Diplomatic handling of staff with considerable experience in the design and layout of chemical plant are essential. Minimum qualifications H.N.C. The position is pensionable and the salary will be commensurate with experience and ability. Full particulars.—BOX No. E8880, "The Engineer." A

CHIEF DRAUGHTSMAN/DESIGN ENGINEER required, due to promotion, to control drawing-office of expanding chemical works. Experience in process industry desirable. Good salary, staff bonus and contributory superannuation schemes. Housing assistance.—Write (in confidence) to Engineering Dept. Manager, JOHN & E. STURGE, LTD., Denison Road, Selby, Yorkshire. E8951 A

CHIEF MECHANICAL ENGINEER. Large Opencast Mining Company require in SIERRA LEONE professionally qualified ENGINEER with experience in responsible charge. Duties include responsibility for mechanical and electrical work connected with extensive earthmoving machinery, belt conveyors, power houses, workshops, &c. Age not under 35. Commencing salary £3000 per annum plus 5 per cent bonus plus, for married man, passage or separation allowance of £10 per month and £5 per month for each child. 15-month tours followed by liberal leave on full salary in U.K. Return passage paid. Free furnished quarters and medical attention. Contributory Pension Scheme with retirement at age 55. Life Assurance and Dependents Income Schemes.—Write giving full details experience stating age, married or single, to SIERRA LEONE DEVELOPMENT CO., LTD., Dept. C7, City-Gate House, Finsbury Square, E.C.2. E8924 A

CROSSE AND BLACKWELL INVITE APPLICATIONS for the post of CAN-MAKING ENGINEER to run can-making plants and assist on development. This is a managerial position and carries a salary commensurate with the duties.—Apply in confidence to Secretary, Crosse and Blackwell, Ltd., 20, Soho Square, London, W.1. E8929 A

DESIGNER DRAUGHTSMAN urgently required for interesting work in connection with special crane type structures, hoisting machinery (steam, diesel, electric) and contractors' plant. Candidates should have a H.N.C. in Mechanical Engineering, be at least 28 years of age, and capable of accepting responsibility for complete projects. Contributory pension scheme, canteen facilities and convenient transport.—Apply in writing, giving full particulars of age, experience, qualifications and salary required, to the Personnel Officer, The British Steel Piling Co., Ltd., Claydon, Suffolk. E8873 A

DRAUGHTSMEN required by Consultants in Victoria area. Fully experienced in heating or ventilating work. High standards essential and experience in a consultants' office desirable. Salaries up to £1100, according to experience and qualifications.—A. F. MYERS & PARTNERS, 147, Victoria Street, London, S.W.1. E2135 A

DRAUGHTSMAN/TECHNICAL ASSISTANT required by Consulting Engineers, for work connected with Dredgers and similar vessels. Preference given to candidates with both hull and machinery experience. Minimum qualification, O.N.C. Naval Architecture or Mechanical Engineering.—Apply, Personnel Dept., SIR BRUCE WHITE, WOLFE BARRY AND PARTNERS, 1, Lygon Place, Grosvenor Gardens, London, S.W.1 (Tel.: Sloane 3433). E8907 A

ELECTRICAL ENGINEER required with design experience of electro magnets, solenoids, lifting magnets, &c., age 30–45, by old-established firm Manchester area. Good opportunity for suitable man, pension scheme and assistance with housing.—Please give full particulars of experience, qualifications and present salary or salary expected to BOX No. E2143, "The Engineer." A

ELECTRICAL ENGINEERS

Associated Electrical Industries, Heavy Plant Division, Manchester, require Electrical Engineers for the design and development of large rotating electrical machines for hydro power stations and industrial applications (A.C. and D.C.).

The desired age range for candidates is 25–35 and they should preferably have served a recognised engineering apprenticeship. It would be an advantage to have had some experience in the design of rotating electrical plant or in a drawing-office associated with this work.

The minimum qualifications for these posts is Grad.I.E.E., but men with the Higher National Certificate, who shortly expect to become Graduate members of the Institution will be considered.

Applications, stating age, qualifications and experience and quoting reference B.12, should be sent to :—

Personnel Manager,
METROPOLITAN-VICKERS ELECTRICAL CO., LTD.,
Trafford Park,
Manchester, 17.

E8906 A

ENGINEER REQUIRED to take charge of Chemical Plant Drawing Office. Applicant should be not less than 30 years of age and have held a similar position for a period of at least 5 years. Good salary commensurate with experience and qualifications.—The Coniston Company, Eagle House, High Street, Wimbledon, S.W.19. E2141 A

ENGINEER WANTED for Textile Mill and Works in East Africa, for general maintenance of plant and buildings. Experience in finishing machinery an advantage. Please reply with full particulars of experience, age, family, &c.—BOX No. E8947, "The Engineer." A

ENGINEERS required (aged 28–50), with good experience of either machining, presswork, machine tool design, work study or method study. Responsible positions on the development of engineering equipment and manufacturing processes. An engineering qualification would be advantageous but is not essential. Good opportunities for successful applicants. Excellent working conditions in pleasant surroundings. Pension scheme. Send full details, including qualifications, experience and present salary, in confidence.—BOX No. E8897, "The Engineer." A

ENGINEERS AND PHYSICISTS

Opportunities exist for Engineers and Physicists in one of the country's leading Operational Research Groups. The work involves the application and development of scientific and engineering techniques to a wide variety of problems in the general field of management and is not restricted to the narrow confines of specialist engineering or physics. The work is not easy but is extremely interesting and satisfying. Candidates must hold a good-class Honours Degree and must be under 35 years of age. Candidates expecting to graduate in 1959 are also invited to apply. The initial salary will be in the scale £690–£1200 male, and there are excellent opportunities for further advancement. Interviews will be held in London and informal interviews can be held in the evenings if desired.—Further information and application forms may be obtained from Staff Department (X.1281A), National Coal Board, Hobart House, London, S.W.1, before 3rd November, 1958.

E8890 A

ENGINEER REPRESENTATIVE LONDON

An old-established Midlands firm of Structural Engineers requires an ENGINEER to represent them in London and the South.

Qualifications: age 35 to 38, experience in Structural Engineering, able to conduct negotiations, preferably a member of the Institution of Civil or of Structural Engineers, of good personality and address and possessing initiative.

Office accommodation would be provided together with a salary appropriate to the requirements of the post.

Applicants are invited to write, in confidence, to the Managing Director, the LILLESHALL COMPANY, LTD., St. Georges, Oakengates, Shropshire.

E8805 A

HEATING AND VENTILATING ENGINEERS required by consultants in Victoria area. Capable of accepting design responsibility for large projects and preferably with consulting experience. Salaries up to £1500, according to experience and qualifications.—A. F. MYERS & PARTNERS, 147, Victoria Street, London, S.W.1. E2134 A

Classified Advts. continued on page 106

SITUATIONS VACANT

GRADUATE MECHANICAL ENGINEER

required for development work (London area) connected with pressurised water nuclear reactor system components and other high-pressure plant.

Applicants should have served an apprenticeship and have some industrial experience in the field of high-pressure steam-raising plant.

Please apply in writing, stating age, qualifications and experience, to Staff Manager,
FOSTER WHEELER LIMITED,
3, Ixworth Place,
London, S.W.3. E8899 A

HUNTING ENGINEERING LIMITED
require
SENIOR AND INTERMEDIATE DRAUGHTSMEN

Vacancies exist for men with Structural and Mechanical experience, to carry out work of an interesting nature.

Excellent prospects in a progressive organisation.

Contributory Staff Pension and Life Assurance Scheme.

Applications, giving full details of qualifications, experience, age and salary desired, and quoting ref. H.E.L./57/E, should be forwarded to :—

The Personnel Manager,
Hunting Engineering Limited,
The Airport,
LUTON,
Beds. E8950 A

JUNIOR ENGINEERING DRAUGHTSMAN required in the N.C.B.'s Carbonisation Department in London (near Victoria Station), for general mechanical and layout work. O.N.C. or equivalent is desirable and applicants should preferably have had experience in carbonisation or similar plant work. Appointment (superannuable) and salary according to qualifications and experience, in the scale £530–£675 ; 5-day week, staff canteen, &c.—Write, stating age, education, qualifications and experience, to Staff Department (X.1282 C.), National Coal Board, Hobart House, London, S.W.1, before 3rd November, 1958. E8898 A

LONDON ENGINEERING FIRM, representing leading German Mechanical and Electrical Manufacturers (including Traction and Marine), requires TECHNICAL SALES ENGINEER. The position offers good prospects for young engineer with imagination and initiative. Knowledge German language desirable.—BOX No. E2138, "The Engineer." A

MECHANICAL ENGINEERS

Associated Electrical Industries, Heavy Plant Division, Manchester, require Mechanical Engineers for interesting mechanical design and development work in connection with the electrical design of large rotating plant for hydro power stations and industrial applications.

To facilitate experimental work in these fields, a laboratory is available.

The desired age range for candidates is 25–35, and they should preferably have served a recognised engineering apprenticeship. Some experience of the mechanical design of structures or rotating plant would be an advantage.

The minimum qualifications for these posts is Grad.I.Mech.E., but men with the Higher National Certificate who shortly expect to become Graduates of the Institution will be considered.

Applications, stating age, qualifications and experience and quoting reference C.12, should be sent to :—

Personnel Manager,
METROPOLITAN-VICKERS ELECTRICAL CO., LTD.,
Trafford Park,
Manchester, 17.

E8905 A

RUSTON AND HORNSBY LIMITED
have vacancy for DRAWING OFFICE CHECKER in the Gas Turbine Drawing Office, engaged on the design and application of a diverse range of turbo machinery. Applicants should be aged not more than 35, have considerable drawing-office experience, and will be expected to comment on design aspects as well as being responsible for the standard of drawings for high-class machinery. The position entails liaison with Production and Research Departments to assist section leaders in resolving manufacturing problems. The post is pensionable.—Applications, stating age, qualifications and experience, to Manager of Industrial Relations Department, Ruston and Hornsby, Ltd., Lincoln.

E8887 A

RESIDENT ENGINEER required by the University College of Swansea, to supervise and control a number of mechanical and electrical engineering sub-contracts in connection with building development at the University. Candidates must be not less than 35 years of age and possess technical qualifications up to National Certificate standard, Mechanical and/or Electrical, or be graduate or Associate Members of the Institution of Electrical Engineers or the I.H.V.E. Preference will be given to applicants who have had some design experience, either in heating and ventilation or in electrical installation work, and who have had previous experience in supervision on sites of engineering works. The inclusive salary will be £1000/£1250 per annum, according to experience.—Applications, in writing, should be made to the Architects, Sir Percy Thomas and Son, 10, Cathedral Road, Cardiff, giving full particulars of age, qualifications and experience. Closing date for applications, 10th November, 1958. E2140 A

RUSTON & HORNSBY LIMITED
LINCOLN
WORK STUDY FROM SCRATCH

The introduction of Work Study in these Diesel Engine Works calls for an additional WORK STUDY ENGINEER with at least five years' experience in this field. For the successful qualified man there will be unusual advantages in joining this department, which will rapidly expand. The Work Study experience is essential and engineering apprenticeship and National Certificate would both be desirable. For the enthusiastic, tactful, responsible Work Study Engineer, the prospects will be considerable.

An attractive salary, in accordance with qualifications and experience, will be paid. Post progressive and pensionable.

Applications should be forwarded to the Manager, Industrial Relations Department.

E8900 A

SENIOR DESIGN DRAUGHTSMAN required by development department of large light alloy manufacturing organisation in the West London area. Knowledge of light alloys an advantage, salary commensurate with qualifications and experience, contributory pension scheme in operation.—Write, giving full details, to BOX No. E8859, "The Engineer." A

SENIOR DESIGNER / DRAUGHTSMAN REQUIRED, must be experienced in Chemical Plant and/or Refinery layout. Good salary commensurate with experience and qualifications.—The Coniston Company, Eagle House, High Street, Wimbledon, S.W.19. E2142 A

SENIOR DRAUGHTSMAN, experienced design electrical ancillary equipment, including boxes, busbars, electric cabling, able work own initiative. Also JUNIOR DRAUGHTSMAN, capable of working from design data supplied. Both salaries by arrangement, but not less than A.E.S.D. rates.—Write, with full details, to Eng. Planning Supt., ENFIELD CABLES, LTD., 19/21, Store Street, London, W.C.1. E2150 A

SENIOR ENGINEERING INSPECTOR required at the Barrow-in-Furness factory of the British Laundry Machinery Company, Ltd.—Please write, in confidence, to the Managing Director, Roose Engineering Works, Barrow-in-Furness. E2144 A

SENIOR SALESMAN required by precision engineering company in the Midlands area manufacturing hydraulic equipment and small component parts for machine tool and allied trades. Good education essential. Contributory pension scheme available. Apply in writing, giving full details of training, experience and salary required.—BOX No. E2112, "The Engineer." A

SENIOR SERVICES DRAUGHTSMAN required with experience of Factory services for water, gas, oil and air ; pump installations and pipe layouts. —Write or telephone to Chief Draughtsman, General Engineering Dept., Northern Aluminium Company, Ltd., Rogerstone, Mon. Telephone : Newport 59991/6. E8814 A

SERVICE ENGINEER required, with experience of the application of air pumps in the industrial field. Applicants should preferably have had previous similar experience and possess O.N.C. or the equivalent.—Apply in writing to the Personnel Officer, Sir George Godfrey and Partners, Ltd., Hampton Road West, Hanworth, giving details of experience, age and salary required. E8936 A

THE GLACIER METAL CO., LTD.
invites applications for the post of SERVICE STATION ENGINEER. The person appointed will work as a member of the Company's Technical Division attached to the Manager of it's Glasgow Service Station—a self-contained unit engaged on the specialised production and repair of bearings. The Station Engineer will be responsible for ensuring that high production standards are maintained in the station, must continually investigate areas of production where changes in methods, layout or machinery could lead to increased efficiency, and propose and assist in implementing such changes. Applicants should have had some experience of design work and have served an Engineering Apprenticeship. A knowledge of estimating, plant layout, material handling and work study would be useful. Academic qualifications to the standard of Corporate Membership of I.Mech.E. or I.Prod.E. are desirable. The post presents a good opportunity for a Young Engineer wishing to enter management. Preferred AGE RANGE 25–35 but candidates outside this will be considered. SALARY RANGE £900–£1300 per annum.

Applications should be sent to the Personnel Director, Ref. G.S.E., Glacier Metal Co., Ltd., Ealing Road, Alperton, Wembley, Middlesex. E8870 A

UNION OF SOUTH AFRICA
MECHANICAL INSPECTING ENGINEER required for Johannesburg Office of Consulting Engineers, to deal with the inspection and test of boilers and ancillary mechanical equipment for power plants. Training given to suitable applicant.

For details apply to Merz and McLellan, Milburn, Esher, Surrey. E8895 A

WANTED CHIEF ENGINEER having sound knowledge of Hydraulics for Flow Measurement Company in the London District, must be experienced in design and manufacture of Flow Metering Instruments and Equipment. Position holds good prospects.—Apply giving qualifications, experience, age, and state salary expected to BOX No. E2145, "The Engineer." A

SITUATIONS VACANT

THE TECHNICAL SERVICE SECTION

of Henry Wiggin & Co., Ltd., have vacancies for **MECHANICAL ENGINEERS** to assist in the technical and sales development of their high-temperature nickel-base alloys. Candidates should possess a B.Sc. Engineering degree or an A.I.Mech.E. and should preferably have some industrial experience in the fields of gas turbines, automotive or general high-temperature engineering.

Applications should be made to the Director and Sales Manager, HENRY WIGGIN & CO., LTD., Wiggin Street, Birmingham, 16, marked "Confidential."

E8893 A

MSL have been retained to advise on the appointment of

SENIOR DESIGN ENGINEERS

for an internationally-known company of precision engineers in the North-East engaged in the design and manufacture of highly specialised products.

The company, which is expanding, requires Senior Design Engineers who will be responsible for the development and design of the company's products from the initial stages.

Candidates must have served an apprenticeship in precision engineering and possess professional qualifications (A.M.I.Mech.E. or H.N.C.). They must have extensive design experience and up-to-date knowledge of modern machine tool practice.

Remuneration will be approximately £1,200–£1,500 to start, according to experience, and there are good prospects of advancement. The company is prepared to assist with removal expenses and housing, if necessary.

No information will be disclosed to our clients until candidates know their identity and have given permission after personal discussion. Please send brief details in confidence, quoting reference G.1103, to M. B. Berks.

MANAGEMENT SELECTION LIMITED
17, Stratton Street, London, W.1.

E140 A

SITUATIONS VACANT

CHEMICAL ENGINEERS AND CHEMISTS

PFIZER LTD.,
Sandwich, Kent,

a rapidly expanding pharmaceutical and chemical organisation require Chemical Engineers and Chemists for supervisory duties concerned with the production and control of various pharmaceutical preparations.

Applicants should hold a recognised qualification in either chemical engineering or chemistry. Some industrial experience would be an advantage, but is not essential.

The Company offers attractive working conditions, a pension and life assurance scheme, and a starting salary commensurate with experience and qualifications. Removal expenses are paid.

Applications, giving full details of career, should be made to the:

Personnel Officer, PFIZER LTD.,
137/139 Sandgate Road,
Folkestone, Kent
quoting Reference F6719

E8938 A

SENIOR EXECUTIVE

required for well-known Company marketing new product in material handling field. Will be directly responsible to Board of Directors for all aspects of marketing of product. Sound experience in speciality selling and of Sales organisation essential. The prospects for a successful applicant are exceptionally good and should lead to a Directorship within a few years. In the meantime a good salary at Executive level directly responsible to Directors, with a contributory Superannuation Fund benefit is offered. All replies will be treated in the strictest confidence.—BOX No. E8892, "The Engineer."

A

BRITISH OXYGEN ENGINEERING LIMITED

SPECIFICATIONS ENGINEER

(Chemical Plant and Equipment)

An opportunity has arisen for a young engineer to join our staff as a SPECIFICATIONS ENGINEER. The duties of the post will be to draw up Technical Sales Specifications and to compile Maintenance and Operating Instructions from basic information supplied by the Design Engineer. A man qualified technically to H.N.C. standard would be suitable and he should have had considerable experience in the field of Chemical Plant Design and Manufacture. Previous experience in the field of Technical Writing would be an advantage.

A good commencing salary is offered and excellent conditions of service apply.

Assistance with House Purchase can also be arranged.

Applications in writing giving details of experience, salary and qualifications should be made to :—

The Employment Officer (E.C.1158),
BRITISH OXYGEN ENGINEERING, LIMITED
Angel Road, Edmonton, N.18.

E8881 A

ENGINEERING in the RUBBER MANUFACTURING INDUSTRY?

. . . . . a pertinent question, but one which is easily answered. Never before have there been greater opportunities for engineers, with various qualifications, than exist today at Fort Dunlop—the largest factory in the Dunlop Group. Modern manufacturing techniques call for design and administrative engineers with imagination and drive. The majority of openings are in the field of . . . . .

MECHANICAL ENGINEERING

and are as follows :—

(*a*) Post-graduate apprenticeships offering a sound, practical and administrative training in the extensive engineering departments at Fort Dunlop. This applies to young men who have obtained a degree in mechanical engineering from a British university. A limited number of places are available.

(*b*) Design draughtsmen with National Certificates and appropriate drawing-office experience are required for projects connected with the modernisation and expansion of both the Fort Dunlop Tyre factory and overseas factories of the Dunlop Group. Preference will be given to those with experience of one or more of the following : factory services, plant layout, special-purpose machine design or design of structures, tanks and pressure vessels.

Applications are invited from suitably-qualified men, who should write in confidence, giving details of age, experience and commencing salary expected, to the

Personnel Manager (WT), Fort Dunlop, Erdington, Birmingham, 24.

E8921A

SITUATIONS VACANT

BRITISH OXYGEN GASES LIMITED, Edmonton Works,
invite applications for the post of :

WORKS ENGINEER
(Assistant)

A man with sound practical experience is required for this post. The duties and responsibilities will require a general knowledge of works engineering and will include maintenance of building and the supply of general engineering services. Previous experience in this field is required and qualifications to Higher National Certificate level would be an advantage.

The post is tenable initially at Edmonton and later will transfer to Harlow, Essex.

Excellent salary and conditions of service are offered and assistance with HOUSING can also be given.

Applications should be made in writing, giving full details of experience, qualifications and salary, to :—

Employment Officer (E/C.1160),
BRITISH OXYGEN GASES, LIMITED,
Edmonton Works,
Angel Road, Edmonton, N.18.

E8902 A

SITUATIONS VACANT

ESTIMATING ENGINEERS

with experience of estimating for plant units are invited to apply for appointment with

BRITISH OXYGEN ENGINEERING LIMITED

The posts entail estimating for pressure vessels, compressors, separation columns, scrubbing towers and other units associated with chemical process plant and air separation plant.

Experience in this or an allied field of work is necessary and technical qualifications to Higher National Certificate level would be an advantage.

The posts offer good salaries in an expanding field and assistance with HOUSING can also be given.

Applications, giving full details of age, qualifications and experience, should be addressed to :—

The Employment Officer (E/C.1161),
BRITISH OXYGEN ENGINEERING, LIMITED,
Angel Road, Edmonton, N.18.

E8903 A

SITUATIONS VACANT

SENIOR PRODUCTION ENGINEER

THE GLACIER METAL CO., LTD., KILMARNOCK,
leading manufacturers of Plain Bearings and Centrifugal Oil Filters, are seeking to strengthen their Production Engineering Departments.

Applications are invited from qualified and experienced engineers capable of undertaking a wide range of production engineering activities.

An Engineering Degree and/or Membership of I.Mech.E. or I.Prod.E. are preferred qualifications, and experience of light precision engineering, particularly machining and press tool work, would be an advantage. A lively, enthusiastic and realistic approach to engineering problems is essential.

Starting salaries of £1000/£1200 per annum are envisaged and promotional prospects are excellent. The factory is a modern and expanding one, situated close to the Ayrshire coast.

Brief particulars of qualifications, experience and present salary, to Personnel Manager, The Glacier Metal Co., Ltd., Kilmarnock, Ayrshire.

E8942 A

SITUATIONS WANTED

ENGINER moving south from Glasgow requires position offering prospects in return for genuine experience and ability. Skilled Draughtsman, used to control and administration. Salary £850–£1000. —BOX No. E2416, "The Engineer." B

BUSINESSES and PREMISES

TO LET, Offices, most desirable address, "Westminster"; 2000 sq. ft., ground floor, natural light. Suitable for drawing and other offices. Good lease. —Apply, Secretary, 23, Chandos Court, Caxton Street, S.W.1. E2149 L

Middx – Excellent Modern Factory Premises
FOR SALE FREEHOLD

Total Area about 100,000 sq. ft.
Additional land approx. 1¼ acres.
All services including ample vehicle parking facilities.

FOR IMMEDIATE SALE
£160,000 subject to contract
(VACANT POSSESSION BY ARRANGEMENT)

Apply
Industrial Dept.
GODDARD & SMITH
22 KING STREET, ST. JAMES'S, S.W.1.
Tel.: WHI 2721 (20 lines)

E8925 L

BUSINESS OPPORTUNITIES

£500,000 AVAILABLE

to purchase an old-established Business in any Trade.

Present Management can remain.

Write in confidence to:
REGINALD TERRELL,
BUSINESS BROKERS LTD.
46, St. James's Place, London, S.W.1
(HYD 1678)

E8764 O

PATENTS

THE PROPRIETOR of British Patents Nos. 732,474 and 733,121, entitled "METAL RECUPERATOR STRUCTURES FOR INDUSTRIAL HEATING FURNACES" and "RECUPERATOR STRUCTURES FOR INDUSTRIAL FURNACES," offers same for Licence or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern and Carlberg, 14, E, Jackson Boulevard, Chicago, 4, Illinois, U.S.A. E8834 H

AGENCIES

AGENTS AND SUB-AGENTS required immediately by well-known Building and Civil Engineering Contractors to supervise newly acquired contracts mainly in the North. Qualified men preferred but others of proved ability will be considered. Candidates must have considerable experience with contracting organisations in similar capacity and be reasonably mobile. Salary in accordance with qualifications and experience.—Applications, stating age, training, experience, etc., and quoting post for which applying, should be forwarded to BOX No. E8842, "The Engineer." D

SUB-CONTRACTING

CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process; sample castings treated; A.I.D. approved. —Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone, Byron 1178). E109 MW

KELLERING AND CAM PROFILING capacity up to 8ft by 6ft or 6ft diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone: Knottingley 2743/4). E116 MW

IMMEDIATE drawing office and workshops capacity available for plant design and prototyping of special purpose machinery.—Write Sondes Place Research Institute, Dorking, Surrey. E8771 MW

MISCELLANEOUS

TIME RECORDERS, Sales, Rentals, Service. Telephone Hop 2239.—Time Recorder Supply and Maintenance Co., Ltd., 157–159, Borough High Street, London, S.E.1. E110 I

Classified Advts. continued on page 108

THE NUCLEAR POWER PLANT COMPANY LIMITED

requires

ENGINEERS

to commission Nuclear Power Stations

Applicants should have had considerable operational experience of large Conventional Power Stations and be of either Charge Engineer or Assistant Charge Engineer status.

The Company operates a contributory Pension Scheme and assistance with house purchase is given to married men.

Applications stating age, qualifications and experience should be addressed to :—

The Secretary,
The Nuclear Power Plant Co., Ltd.,
Booths Hall,
Knutsford,
Cheshire.
Quoting reference TE/CMS/59.

E8912 A

ENGINEERING IN NYLON

Applications are invited from Corporate and Graduate Members of the Institutions of Mechanical and Electrical Engineers, who are interested in Research, Experimentation and Development.

This work covers a field which includes Machine Dynamics, Heat Transfer, Servo Control Systems, Electronic Circuit Design, Analogue Simulations and Stress problems.

Each Engineer must be capable of undertaking a variety of problems. He should, therefore, have good academic qualifications and real feeling for this type of work.

These are permanent appointments which will offer good opportunities. Rented houses may be made available and assistance is given with removal expenses.

Applications, quoting 113, which will be treated in confidence, should be addressed to:

The Personnel Manager,
BRITISH NYLON SPINNERS LIMITED,
Pontypool, Monmouthshire.

E8807 A

GENERAL ELECTRIC COMPANY LIMITED
ATOMIC ENERGY DIVISION

MECHANICAL ELECTRICAL & INSTRUMENT COMMISSIONING ENGINEERS

Vacancies exist for the above positions for the commissioning of Nuclear Power Stations. These appointments will be initially for commissioning Hunterston Nuclear Generating Station and specialised training courses will precede this as necessary. Engineers should preferably be Corporate Members of one of the Senior Institutions and a Degree would be an advantage. These positions are permanent, pensionable, and the salaries will be in line with the responsibility involved.

Please apply to the Personnel Manager (RWK), The General Electric Company, Ltd., Fraser and Chalmers Engineering Works, Erith, Kent.

E8910 A

Applications are invited for the following positions in connection with research and development work on heating, air conditioning and refrigeration projects.

DEVELOPMENT ENGINEER

Degree in engineering (alternatively H.N.C. and M.I.Vent.Eng.), with extensive research and development experience, in all aspects of heating, ventilating and refrigeration working with a design and development team on associated projects in an establishment having the fullest facilities and resources.

DESIGNER

Working as part of the team mentioned above, he should hold H.N.C. and have specialised knowledge of air and vapour compressor design, while some experience of ventilating practice, fans, etc., would be an advantage.—BOX No. E8922, "The Engineer." A

DRAUGHTSMEN

Due to expansion in their
MINING DIVISION
Simon-Carves Ltd.
have vacancies for

MECHANICAL DRAUGHTSMEN

for design work on skip and cage winding equipment and general colliery surface plant. Applicants must have D.O. experience in heavy mechanical engineering, preferably in connection with collieries, but men with experience in other fields, e.g. locomotives, armaments, heavy mechanical handling plant, will be considered as well. These positions are permanent and pensionable. Starting salaries within the range £750 to £1000 p.a., depending on previous training and experience. Five-day week, three weeks' annual holiday. Send brief relevant details to Staff and Training Division, SIMON-CARVES LIMITED, Cheadle Heath, Stockport, Cheshire, quoting Ref. CE.18. E8948 A

FOR HIRE

LATTICE STEEL. Erection Masts (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1. ('Phone SLOane 5259). E103 K

HIRE A £1500 CAMERA FOR ONLY £5. All other types of photographic equipment available.—B. Bennett and Sons, Ltd., 25/27, Oxford Street, London, W.1 (Telephone, GERrard 9953). Catalogue on request. E128 K

MACHINERY Etc. WANTED

WANTED

One 25/30-ton E.O.T. Crane, 50–60ft. span.
One 50/60-ton E.O.T. Crane, 50–60ft. span.
Both the above to be suitable for operation on 400V, 3-phase, 50 cy. supply.—Full details, prices, &c., to BOX No. E8766, "The Engineer." F

FOR SALE

FOR SALE BY TENDER

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

Offer for Sale by Tender

SIX AIR BLOWERS

Radial flow centrifugal type with double entry by James Howden and Co. Approximate duty 250,000 c.f.m. at 55in. total water gauge. 2400 h.p. 11kV 3-phase 990 r.p.m. motors by Mather and Platt direct coupled to fan shaft through Wellman-Bibby flexible coupling. Complete with starters, switchgear and control panels.

Approximate dimensions of Blower casing 18ft. 3in. high by 16ft. long by 8ft. 8in. wide. Outside diameter of Impeller 10ft. 10in.

FOUR FANS

Single entry axial inlet centrifugal type by Keith Blackman, Ltd. Approx. duty 8500 c.f.m. at 2¼in. water gauge. 7½ h.p. squirrel cage 415V, 3-phase 50–960 r.p.m. motors direct coupled to fan by flexible coupling. Complete with starters.

The items are available for inspection in a loosely assembled condition at an Authority Works in the North of England. A suitable crane will be available for handling the plant without charge.

Applications for tender documents and permission to view the plant should be made to The Principal Purchasing and Stores Officer, United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley, Near Warrington, Lancs, quoting reference Con/Ris/21137/282.

E8920

FOR SALE

5-ton Coles diesel-driven self-propelled Mobile Crane on pneumatics.

5-ton Morris Versatile diesel/elec. Mobile Crane on solid rubber tyres.

5-ton Smith Steam Loco. Crane 4ft. 8½in. gauge, 35ft. jib, new 1949.

6-ton Rapier Super pet./elec. Mobile Crane on solid rubber tyres.

6-ton Rapier Standard pet./elec. Mobile Crane on solid rubber tyres.

¾ cu. yd. Rapier 410 diesel-driven Excavator with 4-purpose or dragline equipment.

¾ cu. yd. Rapier 423 diesel-driven Excavator with shovel equipment.

1 cu. yd. Rapier 440 diesel-driven Excavator with shovel or dragline equipment.

WILLIAM G. SEARCH, LIMITED,
WHITEHALL ROAD, LEEDS, 12.
Tel. : 639081 (10 lines).
SEARCH (LIVERPOOL), LIMITED
HAMMOND ROAD,
KIRKBY TRADING ESTATE, LIVERPOOL.
Tel. : Simonswood 3361 (5 lines).
E8923 G

HORIZONTAL SURFACE GRINDER

SNOW N.C. 14in. HORIZONTAL SURFACE GRINDER ; grinding head travel 12ft. ; swivelling magnetic chuck fitted.

F. J. EDWARDS, LTD.,
359–361, EUSTON ROAD,
LONDON, N.W.1.
EUSton 4681 and 3771.

E8889 G

HYDRAULIC PRESSES
HYDRAULIC PUMPS

Hydraulic Accumulators, Valves, Fittings, New and Second-hand. Complete installations.
All kinds of Hydraulic Equipment in stock.
THOMPSON AND SON (MILLWALL), LTD
Cuba Street, Millwall, London, E.14.
East 1844/5.
E111 G

AVAILABLE FOR DISPOSAL.—Six Petters A1 Mark 1 Petrol Engines. Brand new, unused. Reasonable offers considered.—BOX No. E8901, "The Engineer." G

FOR SALE

FRED WATKINS
(ENGINEERING), LTD.

STEAM BOILERS.—Cochran Vertical (New), 8ft. 6in., 8ft., 7ft. 6in., 7ft. and 6ft. in dia., 100/150 lb. w.p. ; reconditioned 8ft. 6in. down to 3ft. dia. ; Economic 4ft. to 11ft. 6in. dia., including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p. ; 300 reconditioned Vertical Crosstube, all sizes.

AIR COMPRESSORS.—Broomwade 400, 300, 200 and 130 cu. ft. ; all motorised ; Reavell Rotary Blowers, 2000 c.f.m., 3–2 p.s.i.

200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.

ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 100 h.p.

CRANES.—Mobile 10-ton Lorain, lorry mounted, 30ft.–70ft. extendable jib ; 6-ton and 4-ton Coles Diesel-Electric ; 3-ton Jones Super 40 (3) ; Neals 2-ton Diesel, 20ft. jibs (2) ; Derrick, 10-ton Henderson Steam, 120ft. jib ; 5-ton Wilson Electric, 70ft. jib ; Steam Loco, 18-ton Brownhoist, 50ft. jib ; 10-ton Coles, 40ft. jib ; 8-ton Wilson, 35ft. jib ; 5-ton Smith, 50ft. jib ; 5-ton Cowans Sheldon, 50ft. jib ; 5-ton Grafton, 38ft. jib ; E.O.T. 40-ton Adamson, 42ft. span ; 20-ton Vaughan, 42ft. span (8) ; Goliath, 40ft. span, 60-ton Clyde, 40-ton Babcock, 10-ton Morris ; 5-ton Henderson, 24ft. 7¼in. span, 1946 ; 5-ton King, 29ft. 3in. span ; 2-ton Morris, 18ft. span ; 2-ton Smith, 34ft' span.

LOCOS.—Fowler Diesel, 150 h.p. (2) ; Ruston Diesel, 80/88 h.p., new 1942 ; Bagnall 14in. by 22in., two oil fired, one coal ; Peckett Steam, 7in. by 12in., 1941 ; also 3 miles track, 24in. gauge Bogies, Turnouts, &c.

STEEL PIPING.—50,000ft., 2in. Galvanised, new ; 60,000ft., 3in. black new ; 5000ft., 8in. seamless ; 1000ft., 12in. seamless ; 500ft., 14in. seamless ; 400ft., 18in. riveted ; 280ft., 21in. o.d. welded flanged ; 3800ft., 21in. seamless flanged ; 500ft., 24in. riveted ; 1450ft., 27in. o.d. welded flanged ; 216ft., 48in. riveted ; 216ft., 60in. riveted.

CAST IRON PIPES.—Large stocks all sizes up to 24in. flanged and s.s. Immediate delivery.

VALVES.—Exceptional Surplus Ministry Lot New Stainless Acid Cocks and Valves, over 5000, immediate delivery, below makers' prices. Large stock, all sizes, Parallel Slide Sluice, Gunmetal, Reducing and Check Valves. List on request.

STORAGE TANKS.—300 cylindrical and rectangular up to 12,000 gallons, for oil and petrol, also sectional steel and cast iron up to 50,000 gallons.

MACHINE TOOLS.—Scriven Plate Bending Rolls, 14ft. by ¼in. ; Robertson Straightening Rolls, 8ft. 6in. by ⅜in. ; Berry Bending Rolls, 7ft. by ½in. ; Tangye 200-ton Hydraulic Vertical Straightening Press, 15ft. by 3ft. table ; Herbert 3ND Miller, 61in. by 15in. table ; Pels Punch and Shears, ⅝in. capacity ; nine new 2 cwt. and 1 cwt. Pneumatic Hammers ; Bliss 14-ton Tapering Press ; Bonn Hydraulic Tube Bender up to 20ft. by 4in. bore ; Bigwood geared Bending and Straightening Machine up to 8in. by 6in. R.S. Joists ; two 40kVA Spot Welding Machines ; Wire drawing machine, 3 die, up to ⅜in. copper ; 50kW Electric Furnace, 1000 deg. Cent., chamber 54in. by 30in. by 21in.

SLING ENGINEERING WORKS
COLEFORD, GLOS.
'Phone : Coleford 2271/2. E106 G

FOR SALE

100 TONS STEEL ANGLES
2in. by 2in. by ¼in. by 15ft. 6in lengths
Price £29 per ton delivered (minimum 1 ton lots).
Write : COX & DANKS, LIMITED,
Frederick Road,
Manchester, 6. E8913 G

FOR SALE

Coleman-Wallwork WT.562 C Shockless Jolt Squeeze Turnover Draw Moulding Machine (1957).

Thermic External Direct-Gas-Fired Heating Unit, with fan, motor and starter (1951).

Two Luke and Spencer Grinding Machines, Duplex High-Speed, 20in. by 2½in. by 7in. Grinding Wheels (1953 and 1955), complete with Sturtevant exhaust units (1957).

Morris Cage Type Electric Hoist, 2 tons (1952).

Pooley Platform Weighing Machine, P.1488/980, 15 cwt. capacity by 1 lb. divisions.

Two Pooley Steel Yards, 50 cwt. capacity, type 1568 by CC No. B 553443/1/2.

Tilghman Shot Blast Cabinet, 7ft. by 4ft. by 3ft. complete with motors and starter (1953).

Offers to MILLER AND CO., LTD., London Road Foundry, Edinburgh, where above plant can be seen. E2147 G

LOCOMOTIVES FOR SALE

Four—16in. Steam Locomotives of Stephenson make built 1937 and 1938 with last major overhauls of locomotive and boiler 1953 and 1954.—Interested parties please apply by letter to reference P/EB, Appleby-Frodingham Steel Co., Scunthorpe. E8840 G

OIL HYDRAULIC CHECK VALVES, 3000 p.s.i., all steel, cadmium plated externally, connections B.S.P. parallel male thread for screwing direct into other units or fitting in pipelines using female fittings ; inlets also fit standard flexible hose fittings ; locally hardened disc can be drilled to provide restricted return flow. Ex stock. Prices, ex works : ⅜in. B.S.P., £2 13s. 0d. ; ½in. B.S.P., £3 17s. 0d. ; 1¼in. B.S.P., £4 19s. 0d., each. Discounts for quantities.—Hydraulic Components Co., 5, Manor Gardens, Scarborough. E2151 G

FOR SALE

SERVICE EDWARDS VALUE

BESCO Size R 150/10, All Steel Press Brake, of steel plate construction, arranged motor drive for 380/420/3/50, pressure exerted approximately 150 tons, forming capacity 10ft. by 3/16in., die opening 1¼in.

RUSHWORTH Power Operated Double-Geared Open-Ended Guillotine Shearing Machine, overcrank type, arranged motor drive for 380/440/3/50, capacity mild steel 4ft. by ⅜in., gap in open ends 6½in., weight approximately 50 cwt.

NEW MUBEA All Steel Construction Bar and Angle Shear, arranged motor drive for 400/3/50, capacity round bars 2in., square bars 2in., flat iron 10in. by ¾in., 5½in. by 1in., angles up to 4in. by ½in., 5in. by 0·425in., tee iron 5in., beams 6in., channels 6in., length of blades 12½in.

TWO NEW BESCO Type F, 80½in. by 14 gauge Hand-Operated Universal Swing Beam Folding Machines, with high lift clamping beam and adjustable bed, smallest trunk section formed 11in. by 9¼in., maximum working length 80½in., capacity mild steel 14 s.w.g., height of lift of clamping beam 6in.

TAYLOR & CHALLEN No. 5 TDP, Double-Sided, Double-Geared, Double Action Toggle Drawing Press, arranged for belt drive, fitted with automatic safety guard, punch stroke 12in., blankholder stroke 7in., between uprights 29½in., size of bed 27in. diameter, weight approximately 196 cwt.

WESTON Model 400/100, Double-Sided Friction Screw Press, of welded steel plate construction, arranged motor drive for 400/3/50, pressure exerted approximately 120 tons, maximum stroke 11in., diameter of screw with four starts 6½in., size of bed 21⅛in. by 18in., weight approximately 5 tons 8 cwt.

Photographs of the above are available.

MACHINE TOOLS, NEW AND USED,
Of Every Description. Attractive Prices.

F. J. EDWARDS LTD.,
359–361, EUSTON ROAD,
LONDON, N.W.1.
Telephone : EUSton 4681–3771,
and at
LANSDOWNE HOUSE, 41, WATER STREET,
BIRMINGHAM, 3.
Telephone : Central 7606–8. E207 G

FOR SALE

5-ton capacity Anderson Grice, 3-motor, cab-controlled Overhead Electric Travelling Crane, 47ft. 9½in. span, electrics 440/3/50, new 1942.

5-ton ditto, 36ft. 3in. span, new 1942.

5-ton ditto by Heywood 31ft 3in. span, new 1942.

F. BURRILL & CO.,
235a, Cathedral Road, Cardiff.
Tel. : 26100. E8914 G

METROPOLITAN-VICKERS 500 H.P. SLIP-RING ELECTRIC MOTOR, 196 r.p.m., 400/440/3/50 cycles, complete with control panel and reduction gearbox, giving a final speed of 8·1 r.p.m.

Motor and gearbox available separately if required.

JOHN CASHMORE, LTD.,
Newport, Mon.
Tel. : Newport 66941 (6 lines).
E120 G

FOR SALE

INGERSOLL RAND MODEL "QM-2" QUARRYMASTER PRIMARY BLAST HOLE DRILL RIG, completely self-contained and self-propelled. Rods and spares also available, 3 years old, well maintained throughout. Lying Buckinghamshire area.—Further details from BOX E 488, T.P.E., Romano House, 399/401, Strand, London, W.C.2.

E8940 G

FOR SALE

One Sand Clarifier Plant and Disintegrator, by Foundry Equipment, Ltd.
One Coremaking Machine, by Fordath, Ltd.
One Sand Mixer, Model C.A., by Fordath, Ltd.
One Moulding Machine, Jolt Squeeze, A.T.2. by British Moulding Machines, Ltd.
One Moulding Machine Jolt Squeeze, A.T.4, by British Moulding Machines, Ltd.
All in excellent mechanical condition.
Various Sterling Moulding Boxes, 20in. by 15in. by 3in., by 5in. and 7in., and 32in. by 16in. by 8in.
Apply : H. AND E. LINTOTT, LTD., Engineering Works, Foundry Lane, Horsham, Sussex.
E2148 G

TWO BELLISS & MORCOM 2500 C.F.M. COMPRESSORS, 100 lb. w.p., 550 h.p. motors, 6600/3/50 supply. Used 4 years only. With Inter. and Aftercoolers, Receiver, Switchpanel. Available immediately.—FRED WATKINS (ENGINEERING), LTD., COLEFORD, GLOS. 'Phone : Coleford 2271/2/3. E139 G

NISSEN TYPE HUTS for sale. Prompt despatch of 16ft., 24ft. and 30ft. wide huts ; also "Romney" Huts, 35ft. wide, and "Blister" Hangars, 86ft. 6in. and 91ft. wide. These buildings are in various lengths and comprise steel framework with galvanised corrugated steel sheeting.—Full details from Dept. 115, J. Thorn and Sons, Ltd., Brampton Road, Bexleyheath, Kent (Tel. Bexleyheath 305). E113 G

FOR SALE

WICKSTEED HACKSAWING MACHINE
Serial No. H.1544.
6in. capacity, hydraulic resistance operated.
2 speeds : 130 strokes per min.
90 strokes per min.
Electric motor drive : 440V., 3 phase, 50 cycles. 1½ h.p., 1400 r.p.m.
Using blades 13 or 14g × 6 teeth per inch, 14in. long.
With built-in coolant unit.
The machine is in working order and has not yet been taken out of service so that potential purchasers can inspect it at work.
Inspection invited by appointment with Appleby-Frodingham Steel Co., reference P/EB., Scunthorpe, Lincolnshire. E8872 G

NO. 23 COCHRAN BOILER 105 lbs. W/P. 6030/8050 lbs. per hr. evap. complete with mountings and feed pump for immediate delivery from stock.
ABELSON AND CO. (ENGINEERS), LTD.,
Coventry Road, Sheldon, Birmingham, 26.
SHELdon 2424. E8926 G

WILL INVEST UP TO $1,000,000 WORTH OF PRESSES in well-rated metal-working manufacturing firms.—Montgomery Engineering Co., 11201, French Road, Detroit 34, Mich., U.S.A. E8930 G

YOU'RE ON THE TARGET IF YOU REMEMBER

WARDS might have it!
THOS. W. WARD LTD
ALBION WORKS, SHEFFIELD

HAMMERED OR HYDRAULIC PRESSED
FORGINGS
IN STEEL
BLACK OR MACHINED
TO 24 TONS
INCE FORGE CO. WIGAN
PARKS FORGE LTD
PROPRIETORS

Samuel Marsden & SON LTD
Altrincham St., Manchester 1
London: W. Kelway-Bamber & Co. Ltd., Room 7, 70 Victoria Street, S.W.1. Tel: Abbey 6860
N.E. Coast: Fasteners Ltd., 2 Hall St., Barnard Castle, Co. Durham. Tel: Barnard Castle 3172
dmSM44

FOR SALE

SOAG

OFFER
GOOD CLASS
HEAVY DUTY MACHINE TOOLS
A SELECTION FROM OUR STOCKS

RICHARDS 10ft. Vertical Borer, 2 T.H. on cross rail, 108in. table, h.p. motor 25.
SONDERMANN & STIER 79in. Vertical Borer type KD.20, 2 toolheads on cross rail, 71in. table, motor 20 h.p.
WEBSTER & BENNETT 48in. Maxipower single column Vertical Borer, max. swing 52in., main motor 30 h.p.
HARVEY 30in. Long Bed SS and SC Lathe, motor drive, two saddles with rapid power traverse, between centres 61ft.
CRAVEN 10in. SS and SC Lathe, motor drive, Vee Bed, swing over saddles 26in., between centres 28ft.
CINCINNATI 28-60 Hydro-Tel Vertical Milling Machine, 83in. by 28in. table, capacity 60in. by 30in. by 14in., 16 spindle speeds 52–1300 r.p.m.
HERBERT No. 47V Kneeless Type Vertical Milling machine, 72in. by 17in. table, capacity 48in. by 16in.
WARD No. 10 Combination Turret Lathe for chuck work, swing over bed 23in., spindle nose to turret face 66in., speed range 16–470 r.p.m.
MUIR MT.9 Heavy Duty large capacity universal Gear Hobber, max. dia. of spur gears and worm wheels 90in., max. D.P. 1¼in., hob speeds 18–90 r.p.m., h.p. of main motor 12.
U.L.R.O. Double Column Planing Machine, capacity 12ft. by 5ft. by 5ft., built 1946, 2 heads on cross rail and 2 side heads, A.C./D.C. Lancashire Dynamo drive, table speed up to 120ft. p.m.
NOBLE & LUND Plano Miller 12ft. by 6ft. by 6ft. Multi-motor drive, push button control, one swivel toolhead on cross rail and one side head.

IT'S CHEAPER TO BUY NOW !

We specialise in rebuilding the heavier types of machine tools and would welcome your enquiries.

SOAG MACHINE TOOLS, LTD.,
JUXON STREET, LAMBETH, LONDON, S.E.11.
'Phone : RELiance 7201.
'Grams : Sotoolsag, London, S.E.11.
E212 G

600

Unused Horizontal, Two Column, HYDRAULIC UPSETTING PRESS by Foster Yates and Thom. To accommodate up to 3¼in. max. dia., upsetting up to 3¼in. dia. Main forming ram 9¾in. × 20in. stroke exerts load of 100 tons at 3300 lb./sq. inch, crosshead returned by two 3in. dia. pistons. Working pressure 1500 lb./sq. inch. Die casing operated by two 7¼in. dia. gripping rams, each exerting load of 65 tons, stroke 2ft. 3¼in. Withdrawing operation by two 7¼in. dia. rams, each exerting a load of 30 tons at a pressure of 1500 lb./sq. inch. Vertical intensifier. Low pressure ram, 1500 lb./sq. inch. High pressure ram, 3300 lb./sq. inch.

GEORGE COHEN,
SONS AND CO. LTD.
SUNBEAM ROAD, N.W.10.
Tel.: Elgar 7222/7.
STANNINGLEY, Nr. LEEDS.
Tel.: Pudsey 2241. E204 G

FOR DISPOSAL—NEW CENTRIFUGAL PUMPS, by the Pulsometer Engineering Co., Ltd. Bare shafts but, if desired, can be supplied with prime movers.

Type	Suction	Delivery	Max. Head	G.p.m.
HSL8	10in.	8in.	28ft.	2000
FW4	4in.	4in.	100ft.	400
UNISTREAM	3in.	2½in.	160ft.	100
A4	5in.	4in.	73ft.	250
A2½	3in.	2½in.	86ft.	115

CENTRIFUGAL PUMPS, by Worthington-Simpson, Ltd. Bare shafts but, if desired, can be supplied with prime movers. Two unused "EVAC," self-priming type. Size 2in./3in., 100 g.p.m., 60ft. head. Two reconditioned type L, 8in. suction, 6in. delivery, maximum head 116ft., 1080 g.p.m. One reconditioned type L, 6in. suction, 4in. delivery, maximum head 60ft., 420 g.p.m. One reconditioned type L, 5in. suction 4in. delivery, maximum head 52ft., 430 g.p.m. Full details and prices on application.
Your enquiries invited for PUMPS AND PUMPING SETS—all sizes, duties and types (centrifugal, turbine, diaphragm and reciprocating). Motor, engine or belt-driven.
Stockists of "MONO" pumps for domestic and industrial purposes.

STANLEY ENGINEERING CO.,
TRIANGLE NORTH,
OLDFIELD PARK, BATH.
Telephone : Bath 4294. Established 1910.
Telegrams : "Trius." E8850 G

NEW OVERHEAD CRANES

60-ton Goliath, by Clyde, 40ft. span, 5-ton auxiliary ; cab control, 400/3/50.
40-ton Goliath, by Babcock and Wilcox, 40ft. span, 5-ton auxiliary ; cab control, 400/3/50.
40-ton Adamson, standard cab control, 42ft. 3in. span, 400/3/50.
40-ton Clyde, 42ft. 3in. span, with 20-ton aux., unused.
30-ton Adamson, 42ft. 3in. span, 5-ton aux. ; new in cases.
30-ton Vaughan, 42ft. 3in. span, almost new.
20-ton Vaughan, 42ft. 3in. span, 6-ton aux., 17ft. lift, six available.
20-ton King, 42ft. 3in. span, unused.
10-ton Goliath, by Morris, 40ft. span, cab control, 22ft. lift, 400/3/50.
Surplus Unused Ministry Cranes, mainly still packed. Drawings on request. Inspection invited. Bargain prices.

FRED WATKINS (ENGINEERING)
LTD., COLEFORD, GLOS.
Tel. ; Coleford 2271/2/3. E132 G

AUCTIONEERS & VALUERS

By order of Messrs. Gilbertson and Page, Ltd.

FREEHOLD RAILSIDE FACTORY OFFICES AND LAND

situate at
TAMWORTH ROAD, HERTFORD,
approximately 20 miles from London.
Occupying an easily accessible position adjoining the main 'Bus Depot and having a total
FLOOR SPACE OF APPROX. 62,400 SQ. FT. with frontage
LAND FOR EXTENSION OF ABOUT AN ACRE.
Substantial Mainly Two-Floor Buildings.
Good vehicular access. Private rail siding.
All usual services.
About 19,900 sq. ft. is let and produces £1450 p.a.
Vacant possession of remainder.
To be offered for SALE BY AUCTION (unless previously sold) on
THURSDAY, 27th NOVEMBER, 1958,
at THE LONDON AUCTION MART,
155, QUEEN VICTORIA STREET, E.C.4,
at 2.30 p.m.
By the Joint Auctioneers :

John D. Wood & Co.,
23, Berkeley Square, London, W.1. Tel.: MAYfair 6341 (10 lines).

Henry Butcher & Co.,
73, Chancery Lane, London, W.C.2. Tel.: HOLborn 8411 (8 lines).

Solicitors : Messrs. WARRENS, 5, Bedford Square, London, W.C.1. Tel. MUSeum 7405.
E8954 J

JOHN FOORD
& COMPANY
VALUERS AND ASSESSORS
OF WORKS, FACTORIES
ENGINEERING PLANT
AND MACHINERY
56, VICTORIA STREET,
LONDON, S.W.1.
VICTORIA 2002/3/4
Established Over a Century

FOR SALE

600

Two 1000kW. BELLISS & MORCOM/HARLAND ENG. CO., LTD., back pressure type Turbo-Alternator Sets for 3300/3/50, designed to work with steam at 195 p.s.i., exhausting against 15 lb. back pressure.
New 20,000 c.f.m. Turbo-Compressor by DANIEL ADAMSON, 100 p.s.i., direct-coupled through gearbox to 4145 h.p. synchronous motor by Met.-Vick, 6·6kV./3/50, with control gear and all standard ancillaries.
Two New 1050kVA., 440/3/50, 4-wire Diesel-engine-driven Alternator Sets by MIRRLEES/E.C.C., speed 428 r.p.m., with control gear and standard ancillaries, also starting equipment.

GEORGE COHEN,
SONS AND CO. LTD.
WOOD LANE, LONDON, W.12.
Tel.: Shepherds Bush 2070 ; and
STANNINGLEY, Nr. LEEDS.
Tel.: Pudsey 2241. E202 G

FOR SALE

5340-ton HYDRAULIC RUBBER DIE PRESS by John Shaw, rubber pad 6ft. by 4ft., with self-contained Pumping Equipment.
2000-ton HYDRAULIC FORMING AND DRAWING PRESS, die cushion 12ft. 6in. by 7ft. 6in., with self-contained Pumping Unit.
800-ton HYDRAULIC FLANGING PRESS by Hydraulik Duisberg, 3 main rams, 4 vicing rams, table 16ft. dia., daylight 10ft.
500-ton HORIZONTAL EXTRUSION PRESS for sections with self-contained oil Pumping Unit.
ABOVE ARE SELECTED ITEMS FROM OUR LARGE STOCK OF HEAVY PRESSES.

REED BROTHERS (ENGINEERING), LTD.,
Replant Works,
Woolwich Industrial Estate,
London, S.E.18.
Telephone : Woolwich 7611/6.
E8931 G

UNUSED SET OF PLATE BENDING ROLLS, capacity 32ft. by 1in. down to 6ft. by 2¼in., mild steel plate ; 75 h.p. roll drive, 40 h.p. screw-down ; electrics 400/3/50.—BOX No. E8932, "The Engineer." G

AUCTIONEERS & VALUERS

HENRY BUTCHER
AND CO.
Auctioneers, Valuers
and Surveyors
Specialising
in the
SALE & VALUATION
of
ENGINEERING & ALLIED
WORKS
PLANT & MACHINERY
73, Chancery Lane, London,
W.C.2.
HOLBORN 8411 (8 lines

ESTABLISHED 1877
LEOPOLD
FARMER & SONS
conduct
AUCTION SALES
and
VALUATIONS
OF PLANT, MACHINERY AND INDUSTRIAL PROPERTIES
FACTORY INVESTMENTS
MORTGAGES ARRANGED
46, GRESHAM STREET,
LONDON, E.C.2.
Telephone : Monarch 3422 (8 lines
Telegrams Sites, Londo

AUCTIONEERS & VALUERS

Established 1850
WHEATLEY KIRK
PRICE & CO.
E. L. JUDSON, F.R.I.C.S., F.A.I.
E. BEDDARD, A.I.MECH.E., F.A.L.P.A.
M. S. CHEAVIN, F.A.I.
G. E. GIBBS, F.A.L.P.A.
SURVEYORS, VALUERS
and AUCTIONEERS of
FACTORIES, PLANT and
MACHINERY
FIRE LOSS ASSESSORS
9, REX PLACE, LONDON, W.1.
Telephone : HYDE PARK 8844/5/6 (3 lines)

Established 1807
FULLER, HORSEY
SONS & CASSELL
Specialists
IN THE
SALE & VALUATION
OF
WORKS and MANUFACTORIES
ENGINEERING PLANT
and MACHINERY
10, LLOYD'S AVENUE,
LONDON, E.C.3.
Telephone : ROYAL 4861

E R

By Order of the Minister of Supply

GOVERNMENT SURPLUS STORES

SALES BY AUCTION

		Main Location	*Auctioneers*
October 29–30	**Miscellaneous stores,** including clothing, canteen equipment, hutting, etc.	Northern Command, Ordnance Sub Depot, **Barlow, Nr. Selby, Yorkshire.**	**BARTLE & SONS** (Dept. L), 50–52, Merrion Street, Leeds, 2. (Tel.: 2.0898.)
November 5–6	**Machine tools and miscellaneous stores,** including	Technical Stores Depot, **Old Dalby, Melton Mowbray, Leics.** (Sale at Melton Mowbray.)	**SHOULER & SON** (Dept. L), 1, Norman Street, Melton Mowbray, Leics. (Tel.: 3081.)
	Cincinnati and other horizontal and vertical millers, turret and centre lathes, shapers, Paddon re-boring machines, arc welders, pillar and bench drills, portable electric drills, saws, sanders and grinders, pedestal, bench and flex shaft grinders, valve refacers and seat grinders, hacksaws, magnetic chucks, welding kits, saw blades, plane and moulding iron grinders, diamond mounted wheel dressers, oxy-acet. cutting machine, gramophones, projectors, photograph and cine spares, cotton sheeting and blanketing, steel wire rope, lifting tackle, portable runways, wood rollers, beams and skids, truck spares, platform trucks, paint, varnish, soap, whiting, cartons, bags, packing cases, paint canisters, radar trailer vans, etc.		
November 12	**Miscellaneous stores**	15 C.E.S.D., **Arncott, Bicester, Oxon.**	**MIDLAND MARTS, LTD.,** (Dept. L), Market Square, Bicester, Oxon. (Tel.: 73.)
November 17–21	**Vehicles, lifting and earth-moving equipment, ancillaries and spares for civil engineering plant.**	M.O.S. Storage Depot, **Ruddington, Notts.**	**WALKER, WALTON & HANSON** (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 47271.)
November 27	**Miscellaneous stores**	M.O.S. Storage Depot, **Rotherwas, Hereford.**	**RUSSELL, BALDWIN & BRIGHT, LTD.** (Dept. L), 20, King Street, Hereford. (Tel.: 4366.)

Applications for catalogues should be made *only* to the auctioneers shown above (price of catalogues 1s. 0d., P.O. only).

E118 J

HERE THEY COME!

2 GREAT BRITISH CRAWLERS

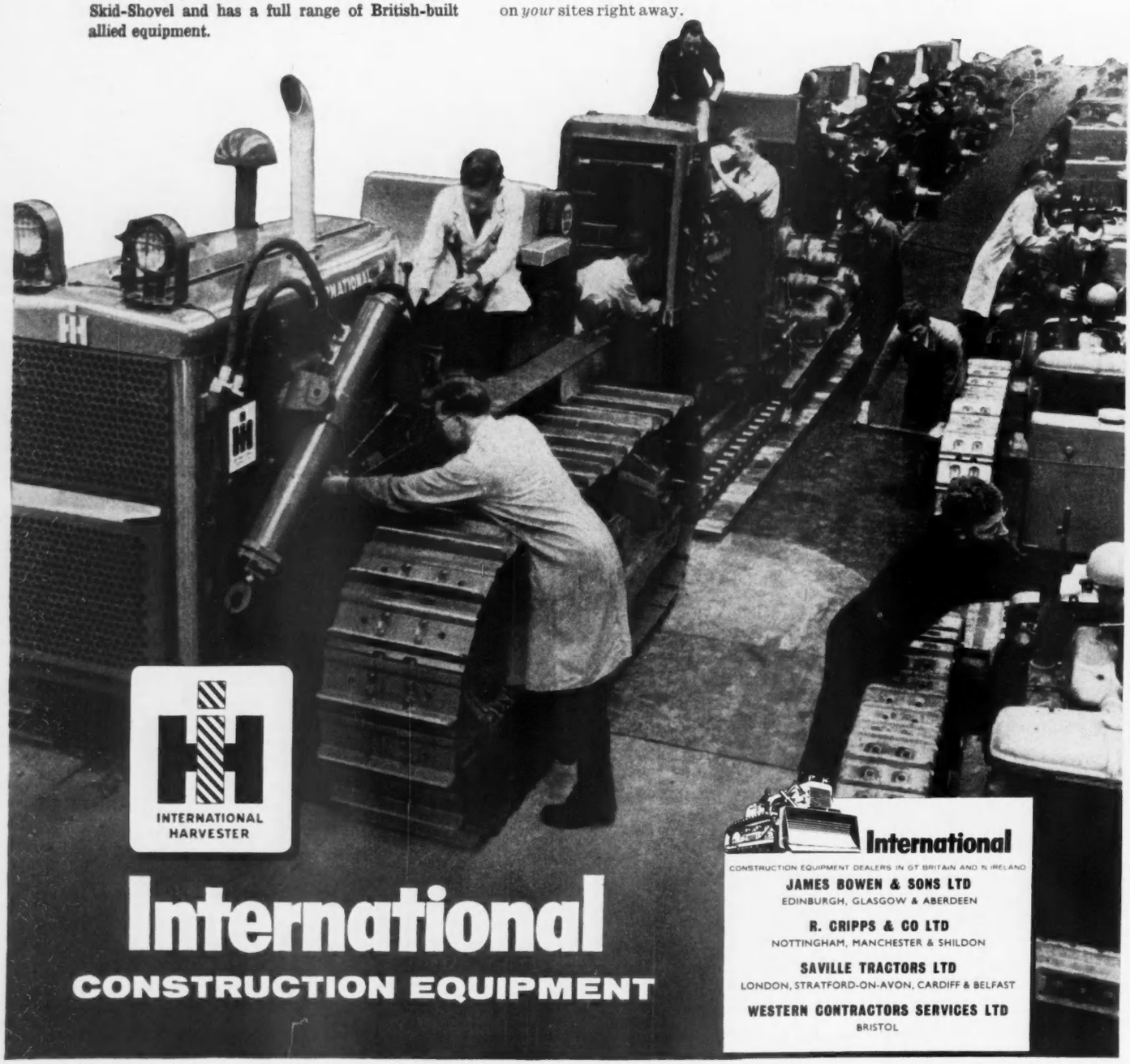
by International

—now rolling off our Doncaster assembly lines by the score!

GREAT NEW BTD-20 has 124 b.h.p. Rolls-Royce diesel engine, hydraulic power steering, and 6-speed, full reverse transmission.

WORLD-FAMOUS BTD-6—most successful crawler tractor ever produced in Britain—powers the Drott Skid-Shovel and has a full range of British-built allied equipment.

Weight for weight, power for power, they're the world's best diesel crawlers. And they're backed by second-to-none International Service. See your International dealer and find out everything you want to know about them. You may well find you'd like to get the BTD-20 or the BTD-6—or both—working on *your* sites right away.



INTERNATIONAL HARVESTER

International

CONSTRUCTION EQUIPMENT

International

CONSTRUCTION EQUIPMENT DEALERS IN GT BRITAIN AND N IRELAND

JAMES BOWEN & SONS LTD
EDINBURGH, GLASGOW & ABERDEEN

R. CRIPPS & CO LTD
NOTTINGHAM, MANCHESTER & SHILDON

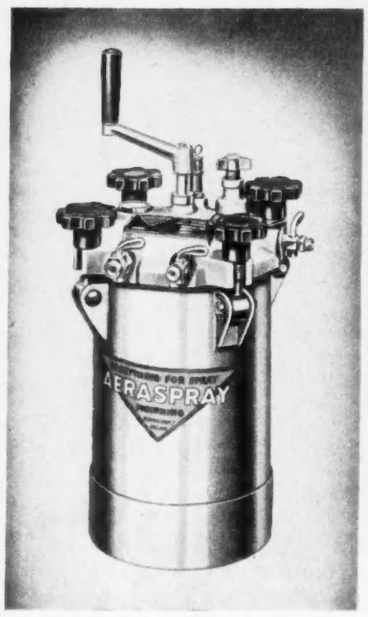
SAVILLE TRACTORS LTD
LONDON, STRATFORD-ON-AVON, CARDIFF & BELFAST

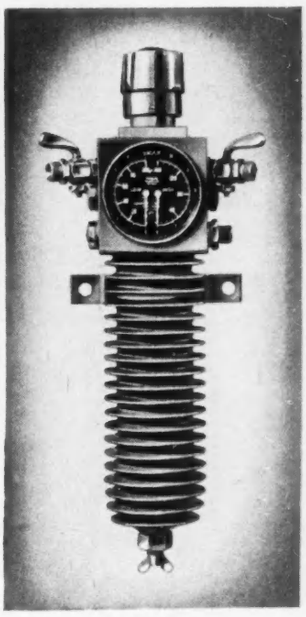
WESTERN CONTRACTORS SERVICES LTD
BRISTOL

INTERNATIONAL HARVESTER COMPANY OF GREAT BRITAIN LIMITED, HARVESTER HOUSE, 259 CITY ROAD, LONDON EC1

INDEX TO ADVERTISERS

	PAGE
AB Atlas Copco/Sweden	45
Abbott & Co. (Newark), Ltd.	66
Abix (Metal Industries), Ltd.	38
Accurate Recording Instrument Co.	54
Acheson Colloids, Ltd.	4
Aerospray Associated, Ltd.	111
Allen, A. H., & Co. (Engineers), Ltd	65
Amal, Ltd.	70
Ashmore, Benson, Pease & Co.	9
Atcost, Ltd	33
Atlas Preservative Co., Ltd.	75
Automotive Products Co., Ltd.	38
B.R.C. Engineering Co., Ltd.	47
B.S.A. Tools, Ltd.	56
BTR Industries, Ltd.	27
Barimar, Ltd.	15
Barron, W. S., & Son, Ltd.	21
Bennett (Hyde), Ltd.	93
Berry, H., & Co., Ltd.	71
Birfield Industries, Ltd.	41
Birkett, T. M., Billington & Newton, Ltd.	99
Birlec, Ltd.	57
Blackheath Stamping Co., Ltd.	82
Bochumer Verein	70
Booth, J., & Bros.	72
Bostock & Bramley, Ltd.	80
Braby, F., & Co., Ltd.	48
Brackett, F. W., & Co., Ltd.	99
Brady, G., & Co., Ltd.	101
British Electrical Development Association	97
British Electrical Repairs, Ltd.	93
British Ermeto Corp., Ltd.	60–90
British Paints, Ltd.	15
British Steam Specialties, Ltd.	70
British Thomson-Houston Co., Ltd.	34
Brockhouse Engineering, Ltd.	91
Bronx Engineering Co., Ltd.	18
Broom & Wade, Ltd.	40
Brown, D., Corporation (Sales), Ltd.	52
Brown, Lenox & Co., Ltd.	61
Brownlie & Murray, Ltd.	93
Brush Electrical Engineering Co., Ltd.	5
Budenberg Gauge Co., Ltd.	99
Butcher, H., & Co.	109
Butterfield, W. P., Ltd.	37
C. & M. Engineering Co., Ltd.	51
C.A.V., Ltd.	32
Caird & Rayner, Ltd.	96
Cambrian Wagon & Engineering Co., Ltd.	6
Carr, C., Ltd.	19
Carter, B. & F., & Co., Ltd.	51
Centrax, Ltd.	16
Clancey, G., Ltd.	4
Clark, G., & Sons (Hull), Ltd.	23
Cleveland Bridge & Engineering Co., Ltd.	24
Clyde Crane & Booth, Ltd.	72
Clyde Crane & Engineering Co.	72
Cohen, G., Sons, & Co., Ltd.	102–Cover ii
Colt Ventilation, Ltd.	13
Coltman, Walter W., & Co., (Boilers), Ltd.	54
Cox & Danks, Ltd.	66
Crane, Ltd.	94
Craven Bros. (Manchester), Ltd.	96
Cross Manufacturing Co. (1938), Ltd.	59
Crossley Bros., Ltd.	88
Cuxson, Gerrard & Co., Ltd.	91
Darlington Forge, Ltd.	44
Dick, R. & J., Ltd.	51
Doxford, W., & Sons (Engineers), Ltd.	26
Drummond-Asquith (Sales), Ltd.	98
Drysdale & Co., Ltd.	94
Du Pont de Nemours & Co. (Inc.)	12
Ductile Sheet Stockists, Ltd.	60
Dunlop Rubber Co., Ltd.	81
Edwards, F. J., Ltd.	3
Electro-Dynamic Construction Co., Ltd.	101
Electroflo Meters Co., Ltd.	Cover iv
Electromagnets, Ltd.	59
Electronic Engineering	36
Elliston, Evans & Jackson, Ltd.	35
Eltron (London), Ltd.	36
English Electric Co., Ltd.	50
Evans, F. W., Ltd.	99
Farmer, L., & Sons	109
Fenner, J. H., & Co., Ltd.	42–43
Fenter, Ltd.	54
Ferranti, Ltd.	76
Filton, Ltd.	27
Flexible Ducting, Ltd.	76
Follsain-Wycliffe Foundries, Ltd.	20
Foord, J., & Co.	109
Ford Motor Co., Ltd.	22–83
Forster, T. S., & Sons, Ltd.	69
Foster Wheeler, Ltd.	83
Fuller, Horsey, Sons & Cassell.	109
Geipel, W., Ltd.	51
General Electric Co., Ltd.	16
Goodyear Tyre & Rubber Co. (Great Britain), Ltd.	Cover iii
Great Eastern Oil Co,. Ltd.	57
Great Eastern Oil Co,. Ltd.	35
Hale & Hale (Tipton), Ltd.	Cover iii
Harland & Wolff, Ltd.	74
Harland Engineering Co., Ltd.	89
Harvey, G. A., & Co. (London), Ltd.	95
Hawke Cable Glands, Ltd.	27
Head Wrightson Teesdale, Ltd.	67
Hermetic Rubber Co., Ltd.	59
Higgs Motors, Ltd.	39
Hill Top Foundry Co., Ltd.	80
Hilton, R. B., Ltd.	69
Hingley, N., & Sons, Ltd.	21
Holbrook	14
Holmes, W. C., & Co., Ltd.	25
Hopkinsons, Ltd.	68
Hudson, R., Ltd.	53
Huntingdon Rubber Co., Ltd.	38
Ince Forge Co.	108
Imperial Chemical Industries, Ltd.	30
International Combustion Products, Ltd.	46
International Harvester Co. of Great Britain, Ltd.	110
International Mechanite Metal Co., Ltd.	86
Jarrow Metal Industries, Ltd.	63
Jenks Bros., Ltd.	62
Kay, S., Rubber Co., Ltd.	4
Kearns, H. W., & Co., Ltd.	77
Kempe's Engineers Year-Book	105
Kirk & Co. (Tubes), Ltd.	19
Lloyd, F. H., & Co., Ltd.	92
Lockwood & Carlisle, Ltd.	36
Maclellan, P. & W., Ltd.	51
Marsden, S., & Son, Ltd.	108
Marshall Fleming & Co., Ltd.	19
Mason, E. N., & Sons, Ltd.	28
Mather & Platt, Ltd.	6
Maxim Conveyors (England), Ltd.	3
Metal Structures, Ltd.	19
Metallic Valve Co., Ltd.	59
Metropolitan-Vickers Electrical Co., Ltd.	64
Midland Industries, Ltd.	90
Mond Nickel Co., Ltd.	Cover i
Monk, A., & Co., Ltd.	55
Morris, B. O., Ltd.	49
Morris, H., Ltd.	7
Neco Geared Motors, Ltd.	100
Newalls Insulation Co., Ltd.	18
Newbury Diesel Co., Ltd.	36
Norris Brothers, Ltd.	36
Nuclear Power Plant Co., Ltd.	87
Oddie Bradbury & Cull, Ltd.	96
Opperman, S. E., Ltd.	37
Osborn, S., & Co., Ltd.	10
Perry Bar Metal Co., Ltd.	31
Phillips, B. L. & N., Ltd.	14
Pinchin, Johnson & Co.	35
Pitman, Sir Isaac, & Sons, Ltd.	105
Planters Engineering Co., Ltd.	62
Pontifex, H., & Sons, Ltd.	82
Pool, J. & F., Ltd.	51
Potter, F. W., & Soar, Ltd.	51
Power-Gas Corporation, Ltd.	9
Pulsometer Engineering Co., Ltd.	24
Ransomes, Sims & Jefferies, Ltd.	27
Rhodes, Gill & Co., Ltd.	66
Richardsons Westgarth (Hartlepool), Ltd.	2
Roballo Engineering Co., Ltd.	73
Robinson, L., & Co. (Gillingham), Ltd.	18
Ross, D., & Partners, Ltd.	100
Sadi Engineering Co., Ltd.	56
Saunders-Roe, Ltd.	62
Savery, T., Pumps, Ltd.	96
Schieldrop & Co., Ltd.	29
Scriven Machine Tools, Ltd.	27
Shannon, Ltd.	17
Sheffield Wire Rope Co., Ltd.	16
Shell-Mex & B.P., Ltd.	78–79
Siebe, Gorman & Co., Ltd.	25
Silentbloc, Ltd.	11
Small & Parkes, Ltd.	24
Smedley Bros., Ltd.	36
Smiths Industrial Instrument Division	8
Spencer - Bonecourt - Clarkson, Ltd.	36
Spirax-Sarco, Ltd.	17
Sterling Metals, Ltd.	74
Sturtevant Engineering Co., Ltd.	54
Sugden, T., Ltd.	20
Sulzer Bros. (London), Ltd.	112
Swindon Tool Co., Ltd.	85
Taylor Industrial Clutches	90
Telco, Ltd.	35
Thornycroft, J. I., & Co., Ltd.	26
Tinsley, H., & Co., Ltd.	91
U.D. Engineering Co., Ltd.	52
United Filters & Engineering, Ltd.	65
Varatio-Strateline Gears, Ltd.	22
Ward, T. W., Ltd.	108
Weir Valves, Ltd.	84
Wellington Tube Works, Ltd.	100
Wells, A. C., & Co., Ltd.	69
West Ham Testing Laboratory	24
Wharton Crane & Hoist Co., Ltd.	58
Wheatley, Kirk, Price & Co.	109
Whitecross Co., Ltd.	3
Wigglesworth, F., & Co., Ltd.	65
Winn, W. M., Ltd.	68
Wiseman, A., & Co., Ltd.	20





AERASPRAY

TRADE MARK

Our Catalogue shows many items of Equipment designed to save you money. The 17 Turntables, for instance, are of 5 types:—Low, ballbearing : Tilting: Powered, Electric or Air: Hydro-pneumatic lifting.

The 15 sizes of Liquid Containers are made in 6 standard forms :— Outlet, top or bottom: Stirrer, hand, air or electric operated. High Pressure type for solids.

Air Rectifiers are made in 20 sizes and types, ranging from a small attachment to fit between gun and hose to the other extreme——— a Mains Filter of 750 c.f.m. capacity.

AERASPRAY ASSOCIATED LIMITED

Head Office & Works: NECHELLS, BIRMINGHAM, 7

Phones: EASt 1671-4, etc.

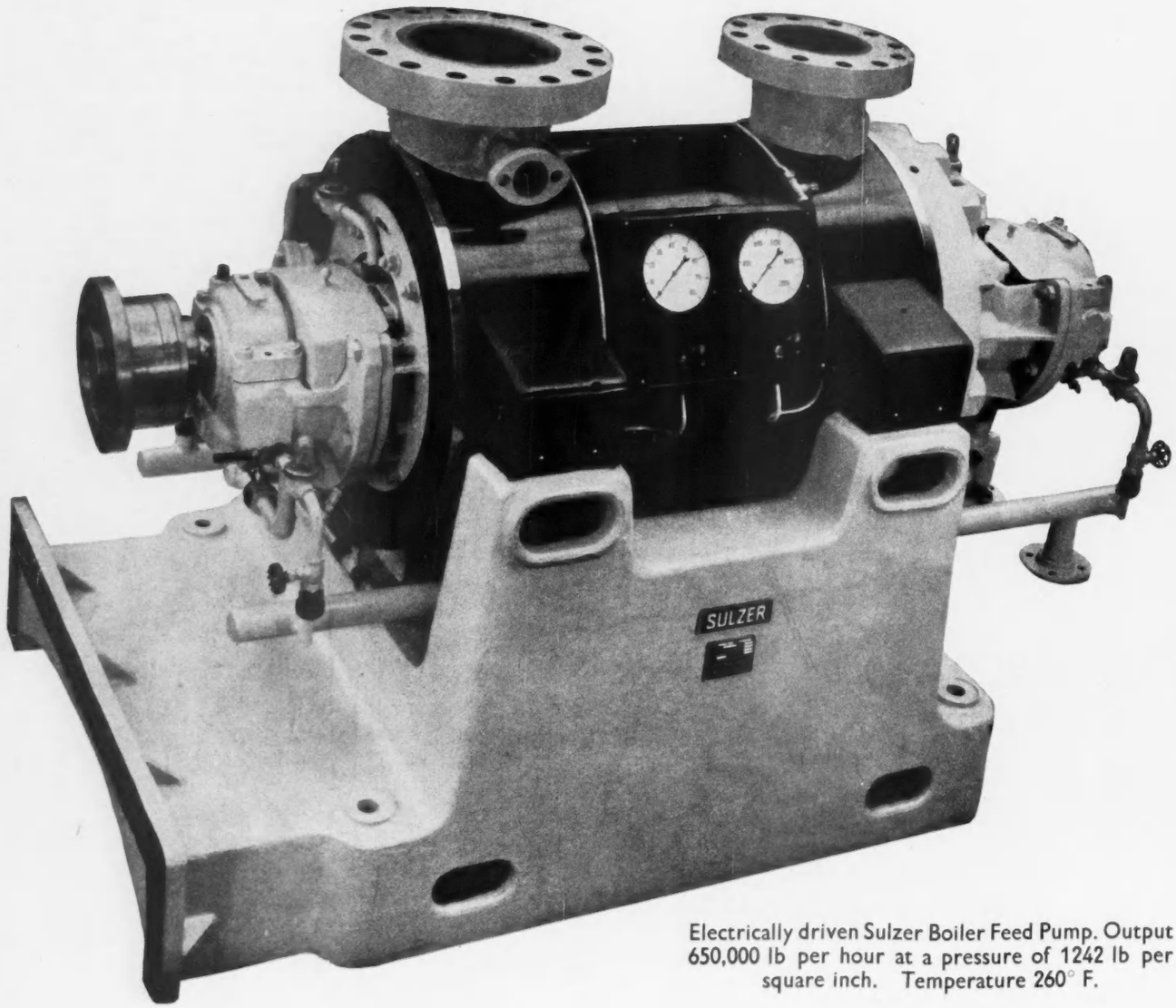
Makers of Spray Guns; Air Compressors; Water Wash etc. Spray Booths; Conveyors; Infra Red etc. Stoves; Automation Equipment.

82, VICTORIA STREET, LONDON, S.W.1. *Phones: ABBey 5095-5096.*

Also at Glasgow, Manchester, Belfast and throughout the world.

SULZER

BOILER-FEED PUMPS



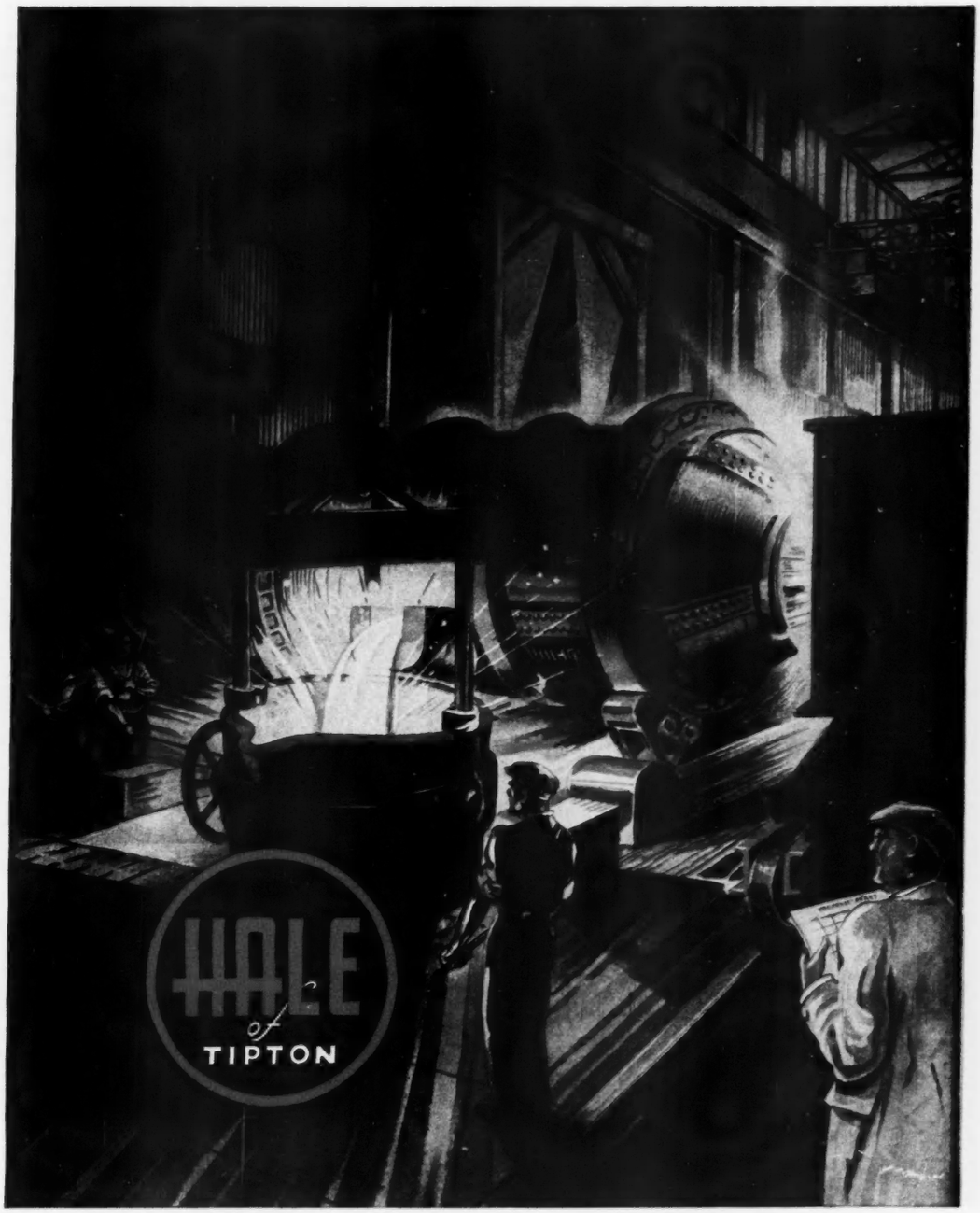
Electrically driven Sulzer Boiler Feed Pump. Output 650,000 lb per hour at a pressure of 1242 lb per square inch. Temperature 260° F.

One of nine units for
MARCHWOOD POWER STATION
CENTRAL ELECTRICITY AUTHORITY

SULZER BROS. (LONDON) LTD., 31, BEDFORD SQUARE, LONDON, W.C.1

SULZER BROTHERS LIMITED HAVE OFFICES AT:— WINTERTHUR - PARIS - NEW YORK - MADRID - CAIRO - RIO DE JANEIRO - BUENOS AIRES - KOBE - LISBON - JOHANNESBURG - MEXICO CITY.
Representatives at:— BRUSSELS - MILAN - AMSTERDAM - COPENHAGEN - OSLO - STOCKHOLM - HELSINKI - ATHENS - ISTANBUL - ALGIERS - HAIFA - BOMBAY - KARACHI - COLOMBO
SINGAPORE - BANGKOK - RANGOON - SAIGON - MANILA - MONTREAL - BOGOTA - CARACAS - SANTIAGO (CHILE) - LIMA - LA PAZ - SYDNEY - MELBOURNE - WELLINGTON - VIENNA

PRINTED BY GEORGE REVEIRS, LTD., 10/12, ROSEBERY AVENUE, LONDON, E.C.1, FOR THE PROPRIETORS, MORGAN BROTHERS (PUBLISHERS), LTD., 28, ESSEX STREET, STRAND, LONDON, W.C.2. 7/11



PRODUCERS OF FINEST BLACKHEART MALLEABLE IRON

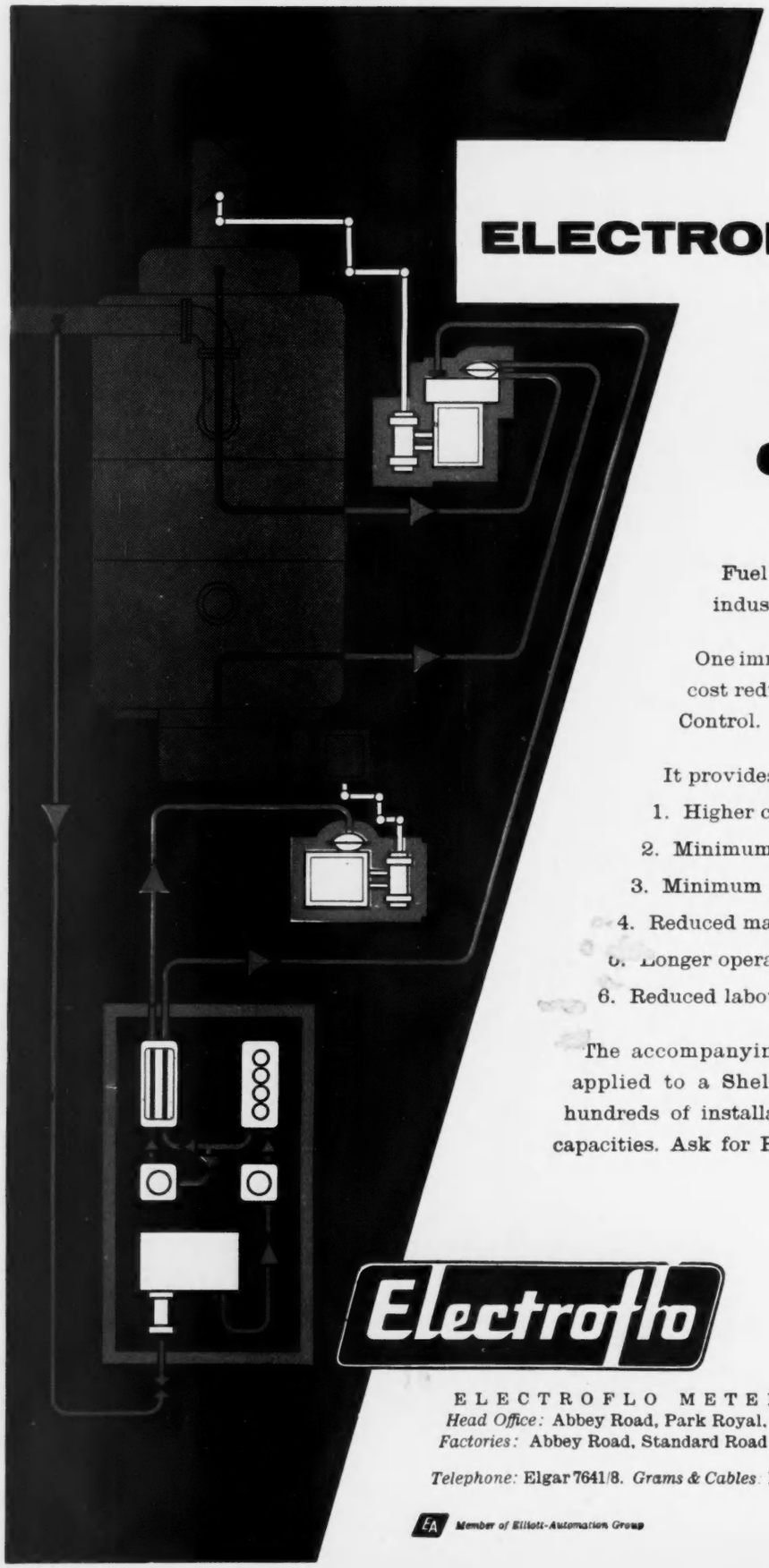
Send for details of our film "Modern Malleable"

HALE & HALE [TIPTON] LIMITED DUDLEY PORT Staffs

GRAMS HALEFO TIPTON PHONES TIPTON 1671/5

The Engineer

OCTOBER 24, 1958



ELECTROFLO-SMOOT Automatic BOILER CONTROL

Fuel costs are high and steam remains industry's most expensive raw material.

One immediately practical, highly effective cost reducer is Electroflo Automatic Boiler Control.

It provides:

1. Higher capacity with safety.
2. Minimum fuel consumption.
3. Minimum air pollution.
4. Reduced maintenance costs.
5. Longer operating periods between overhauls.
6. Reduced labour charges.

The accompanying illustration shows the system applied to a Shell-type boiler—typical of many hundreds of installations on boilers of all types and capacities. Ask for Publication No. 8849.

Electroflo

ELECTROFLO METERS COMPANY LIMITED
Head Office: Abbey Road, Park Royal, London, N.W.10.
Factories: Abbey Road, Standard Road & Minerva Works, Chase Estate, Park Royal and Maryport, Cumberland
Telephone: Elgar 7641/8. *Grams & Cables:* Elflometa, London. *Telex:* Telex No. 2-3196

Member of Elliott-Automation Group